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Vocational Training in
Rural Development and Ecology

Module № 5

Conversion of conventional farming into organic farming

Responsible University

«Yaroslavl State Agricultural Academy»

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Preface

Module №5 «Conversion of conventional farming into organic farming» aims to enhance the competence in the field of organic agriculture and the possible implementation of its principles and methods in practice. The module focuses on the staff of regional and municipal administrations concerned with sustainable rural development and the environment. Therefore the emphasis is rather on the actualization of questions of organic agriculture, then on the realization of principles and methods in specific practical conditions.

The topics of the module cover topical and problematic questions connected with organic agriculture and integrate them in the system where both traditional forms and methods, as well prospective innovative approaches in development of organic agriculture are considered. Therefore we hope that the issues will be of interest to anyone interested in ecological (organic) agriculture. Expected result of this training module is the development of knowledge of a complex approach and the ability to assess efficiency and possibility of modernization and introduction of elements of organic agriculture.

The module was developed in the frame of the Tempus project "Vocational Training in Rural Development and Ecology". In co-operation with eleven Russian agricultural academies and universities, the Russian Federal Ministry of Agriculture, practise partners from the public and private sector in Russia and EU partners from Germany, France, Poland, Italy and Slovak Republic 12 different modules have been developed covering a wide range of topical questions in the field of sustainable rural development. These modules are:

- **Sustainable development: key terms and theoretical basis** (Introductory Module 1, Russian State Agrarian University – Moscow Timiryazev Agricultural Academy)
- **Sustainable rural development: approaches for regional and local programmes elaboration** (Module 2, Russian State Agrarian University – Moscow Timiryazev Agricultural Academy)
- **Ecolabeling and marketing of environmental and regional products from rural areas** (Module 3, Orel State Agrarian University)
- **Eco-tourism and tourism in rural areas** (Module 4, Buryat State Agrarian Academy of Agriculture named after V.R.Philippov)
- **Conversion of conventional farming into organic farming** (Module 5, Yaroslavl State Agricultural Academy)
- **Environmental regulations and laws** (Module 6, Stavropol State Agricultural University)
- **Ecological related problems of intensive agriculture (plant and animal production)** (Module 7, Omsk State Agrarian University)
- **Participatory approach in rural development** (Module 8, Kostroma State Agricultural Academy)
- **Reducing pollution in rural areas caused by agricultural, industrial and municipal solid waste** (Module 9, Novosibirsk State Agrarian University)

- **Sustainable use of water resources in rural areas** (Module 10, Samara State Agricultural Academy)
- **Food safety and product quality control** (Module 11, Moscow State Agroengineering University named after Goryachkin V.P.)
- **Management of biological resources of rural areas** (Module 12, Tambov State University named after G.R. Derzhavin)

The introducing module on the key terms and theoretical basis of sustainable development basis is an ideal preparation for all the above listed specific modules. Persons who start to get involved in the field of ecology and sustainable rural development, we recommend to read this basic module first, before deepening one of the other topics. Readers interested in the modules and further training can address also all involved university partners to get further information or training about the listed modules.

This textbook on module №5 «Conversion of conventional farming into organic farming» was developed by experts from Yaroslavl State Agricultural Academy plus colleagues from Slovak University of Agriculture. Contact addresses are provided in the chapter «RUDECO Partners and Contact Addresses»

Persons dealing with the presented topic №5 «Conversion of conventional farming into organic farming» might be especially interested also in module 1, 3, 4, 7. The topic of module №5 is closely interlinked with module №3 «Ecolabeling and marketing of environmental and regional products from rural areas», module №7 «Ecological related problems of intensive agriculture (plant and animal production)».

The authors are sincerely grateful to professor M. L-Bartosova, as well as staff of the Slovak University of Agriculture in Nitra, E. Gustedt and as well as staff of the Academy for Spatial Research and Planning (Germany), A. Khodus (NP "Agrosophie") for advice and assistance in the collection and compilation of information. Special appreciation we express M. Dietrich, J. Kopsch, A. Thomas and A. Voitenko (University of Hohenheim, Germany).

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Introduction

One of the major conditions to preserve the biosphere and to increase efficiency of agriculture is the construction of management systems, which are based on the principles of energy-saving and ecological balance.

The intensification in agriculture under wide and frequently unsystematic use of synthetic fertilizers and synthetic pesticides, plant growth regulators, genetically modified organisms, power-intensive means of soil tillage can cause serious and even irreversible changes in environment. And the given changes can bear the negative character of degradation of soil fertility, decrease in quality of agricultural production, pollution of environment and foodstuff.

On the other hand, the recent trends in the introduction of energy-saving technologies in production are often accompanied by wrong interpretation of the basic concepts, with substitution and simplification of their content that can also lead to serious environmental problems.

Therefore the comprehensive and complex consideration of problematic questions and the development of the coordinated concept for realization of principles of organic agriculture on the territory of the Russian Federation is necessary.

Transition to ecological (organic) forms of management by simply discontinuing the use of fertilizers, pesticides and other system elements, modern agricultural technologies will lead to a sharp decrease in crop yields and animal productivity. Due to the fact, that this issue should be treated in the framework of Sustainable Rural Development concept, it is necessary to consider technological elements, which characterize the methods of organic agriculture and possible potential of their use without damage for ecology, economy and social sphere. Such a problem solution requires a systematic approach and is impossible only at the farm level.

To support this comprehensive understanding, the module aims to enhance the competence of students in the field of organic agriculture and the possible implementation of its principles and methods in practice. The information presented is focused on the staff of regional and municipal administrations concerned with sustainable rural development and the environment, not necessarily the farmers. In this regard the main accent was made on actualization of questions of organic agriculture, instead of the realization of principles and methods in specific practical conditions as it demands more of their detailed consideration with reference to different agricultural used landscapes. However, we hope that the issues will be of interest to anyone interested in ecological (organic) agriculture.

The main objective of the training on "Conversion of conventional farming into organic farming" is to increase the competence of students in the field of organic agriculture and the possibility of implementing these principles and methods in practice.

Achievement of this goal involves the following tasks:

- Studying questions of the evolvement and development of organic agriculture.
- Comparative assessment of the advantages and disadvantages of organic agriculture.
- Management of soil fertility in organic agriculture.
- Study of methods of organic agriculture, including tillage, crop rotation, crop protection from pests, fertilizers, plant breeding.

- Conceptual understanding of the role of animals in organic agriculture.
- Basic information on organic standards and certification.

Necessary basic knowledge:

Higher education in natural science or agricultural specialties, as well as on humanitarian. Experience in administration at regional and municipal level is desirable.

After module studying you are able:

- to know differences between traditional and organic agriculture;
- to formulate the reasons and the possibility of conversion from conventional to organic agriculture;
- conditions of success of development of organic agriculture in Russia and the world;
- to know methods of organic agriculture;

The contents to study are:

- preconditions of appearance of organic agriculture, history, principles and methods of organic farming;
- soil management in organic agriculture;
- tillage systems and their role in organic agriculture;
- fertilizers in organic farming;
- crop rotation in organic farming;
- crop protection in organic agriculture;
- organic plant breeding and seed production: ecological and ethical aspects;
- organic livestock husbandry and breeding;
- organic Standards and Certification.

Keywords:

Adaptive-landscape system of agriculture, alternative agriculture, biodynamic agriculture, biodiversity, organic farming (agriculture), animal welfare, green manure, monoculture, zero tillage, surface-ploughing treatment, organic products, rural tourism, Eco standard, economic threshold, ecotourism.

1 Background and history of organic agriculture

1.1 Preconditions of appearance of organic agriculture

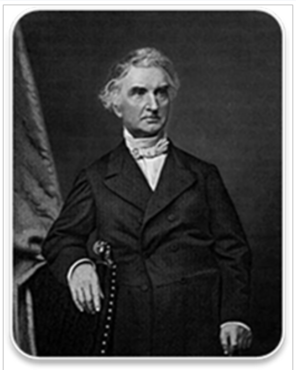
Throughout the development of agriculture people tried to reduce its dependence on the environment and modify it for their own purposes, often depleting natural resources. Scientific and technological progress in the XIX-XX made it possible to subordinate the nature of people needs and manage the many processes occurring in it. However, intensive technogenic impact on the environment may cause a breach of natural interrelations. This leads to the destruction of the entire system of environment and threatens the new, previously unseen problems, the severity of which is so great that we can talk about the threat to the existence of mankind (А.Ю. Мазурова, 2009).

The greatest numbers of large agricultural innovations in agriculture have descended in 19th-20th centuries. A revolution in agriculture has made the spread of chemical fertilizers. The real revolution in agriculture occurred due to the spread of synthetic fertilizers.

Organic agriculture (OA) movements in the major industrial countries - Britain, Germany, Japan, and the U.S. - emerged in the 1930's and 40's as an alternative to the increasing intensification of agriculture, particularly the use of synthetic nitrogen (N) fertilizers (D.W. Lotter, 2003).

Synthetic nitrogen began to become available after World War I when the infrastructure for the manufacture of explosives, based on the Haber-Bosch process for fixation of N, was converted to N fertilizer production (A. C. Morrison, 1937, Г.В. Быков, 1981). Synthetic N fixation enabled a 20-fold reduction in the volume and weight of fertilizer relative to manures, drastically reducing fertilizer transport and application costs per unit of N.

As to Russia till 1917 the industry of synthetic fertilizers has been introduced by small superphosphate factories, and potash and nitrogen fertilizers were not effected almost (Н. Олешкевич, 2008). All production of several shallow factories compounded in 1913 only 89 thousand tons. Building of new factories has begun only in 1925-1926 and has got further the big scope.



Justus von Liebig

(1803-1873)

Appearance of fertilizers is bound to a name of the known German chemist of baron Justus von Liebig, published in 1840 the essay under the interesting name «Chemistry in agricultural industry and physiology». In it an essay he asserts that all necessary for an alive plant can be found in mineral salts which contain in ashes of the plants reduced to ashes for elimination of all organic substances. Results of application of agricultural chemicals from nitrogen, phosphates and a potash together with lime confirmed the theory of Liebig, and have led to unprecedented growth of production of agricultural chemicals and first of all the nitrogenous.(П.Томпкинс и К. Берд 2006, Быков, 1981).

The large nitrogen fertilizer industry in the USSR has started to be created in days of 1st five-year period.

- In 1928 at Chernorechensky factory for the first time in terrain of the former USSR the synthetic ammonia which has begun development of the nitrogenous industry has been received.
- In 1932 the Bereznikovsky Nitrogenous Factory where ammonia production has been organised under the conversion scheme of gasification of coke has been started up.
- In 1933 was the Novomoskovsk chemical factory, and in 1940 - the Kemerovo Nitrogenous Factory is introduced.

After the end of the World War II the development of production of ammonia and nitrogen fertilizers has been continued for the bill of development reacting and buildings of the new enterprises. Production of nitrogen fertilizers in Russia and other republics of the former USSR after discovering of natural gas and building of a herring-bone pattern of mains of the main gas pipelines for its transfer to various economic region and republics especially quickly began to develop.

Result of growth of industrial production of fertilizers was wide and unsystematic use first of all nitrogen fertilizers. Only over the last 50 years the quantity of the nitrogen led in soil has increased in 50 times. It has led to breaking of equation of a ratio between nitrogen and other nutrients (first of all phosphorus and potassium) that has served as the accelerant of many negative phenomena: augmentation of nitrates in food stuffs and deterioration of their quality, decrease in resistance of cultivated plants to diseases and a various kind to stresses, contamination of reservoirs, augmentation of motility of organic substance of soil and decrease in its fertility, etc.

Together with increasing of crop yields and application of fertilizers in first half of XX-th century the enhanced rates the quantity of farm implements and cars on fields increased. Rash application of a plough was at the bottom of development of erosion processes in the USA, Canada, the USSR, countries of Western Europe that has led to decrease in soil fertility and soil degradation.

In 1943-1970 «green revolution» which has led to substantial growth of world agricultural production at the expense of breeding of more productive breeds of plants, dilating of an irrigation, application of fertilizers, pesticides, the modern technique has had development.

In 1941 in England selective and phototoxic properties have been found of the whole group of the substances influencing development of plants - herbicides. This discovery has led to development of preparations 2M-4X. Simultaneously with it in the USA in mag-

By various assessments, from a venenating with agrochemical annually perishes about 200 thousand persons. The part of pesticides remains in food stuffs and gets to an organism of people. Many of them are very resistant to degradation (eg, DDT), getting into the environment, they somehow turn out to be in the human body, showing the negative effects are sometimes only with the passage of time. Some pesticides are capable to invoke chronic diseases, anomalies in newborns, a cancer and other diseases. Pesticides contaminate groundwater and are contained in drinking water, so their distribution may become uncontrolled. These circumstances have led to the fact that some pesticides are banned in developed countries but in developing countries their use is virtually unlimited.

azine «American chemical society» there was a note about synthesis 2,4-dihlor and 2,4,5-trihlorfenoksiuksusnyh acids (2,4-D and 2,4,5) (А.С. Садовский, 2005).

In 1939 the Swiss chemist P.Müller creates insecticide, DDT due to which in some countries has been completely eradicated malaria. According to assessments of National academy of Sciences of the USA, DDT has rescued 500 million lives from a malaria during its application to 1970, and to its author the Nobel Prize on medicine in 1948 has been awarded.

Distribution of pesticides is bound to their high efficacy and low cost. By means of these preparations it was possible to solve serious problems. For example, the special commission of the congress of the USA has come to a conclusion that abandoning of application of pesticides will lead to sharp decrease in production of agriculture and animal husbandry (30 %) and augmentation of the prices at food stuffs at 50-70 %.

Currently the world uses each year 2.3 million tons of pesticides, with 75% - in economically developed countries.

"Green revolution" has led to a sharp jump in the growth productivity of the rural economy in the 1960s and 70s. The use mineral fertilizers and pesticides, along with other scientific and technical achievements allowed to raise grain yields in some European countries up to 80-90 kg / ha - 10 times more than in the Middle Ages.

Social consequences of «green revolution» are difficult for overestimating. As a result of its realization it was possible to lower a food problem sharpness, began possible to release a part of people from agriculture, urbanization process has increased. Population began to grow faster rates.

However, successes of «green revolution» were not equivalent in different regions of the world. New technologies have greatly increased harvests on the fertile soils, but in other areas they are often less effective. This fact led to increased social disparities, as the fertile land is usually owned by rich families. In countries with cheap labour, the use of synthetic fertilizers significantly increased the total cost of products. Many farmers borrowing money for purchase of fertilizers, as a result got to a debtor's prison.

«Green revolution» has allowed the creation of global agrobusiness, which is able to monopolize the American companies, like half a century before that, they monopolized the oil industry. As Henry Kissinger declared in 1970 that «if you control the oil you control the country, if you control food, you control the population».

In 1970 - 80th negative consequences to «green revolution» became obvious, both on environment and on human health. It became apparent that pesticides kill beneficial insects and, sometimes presenting perfect conditions for breeding new pests. Increased nutrient runoff from fields into watercourses caused deterioration of water quality, fish kills and endangered other animal species. The huge areas of ground lands have undergone to land erosion, a salification and reduction of their fertility (Э.П. Романова, Б.А. Алексеев, 2005).

Rachel Louise Carson (1907-1964)

In 1962 was published a book by Rachel Carson's Silent Spring, where the author wrote about the dangers of DDT and other pesticides on the environment. The book it becomes instant the best seller in many countries. Author's ideas were so effective, that is believed to have played a crucial role in banning DDT, the U.S. government and the establishment of an Environmental Protection Agency in 1969. Ten years later for the purpose of information interchange about principles and means of ecologically safe agriculture in France the International Federation of Organic Agriculture Movements (IFOAM) has been based.

Talks about hazard of pesticides uses started some years after their introduction in agriculture. In 1962 the American biologist R. Carson has published the book «Silent Spring» in which negative influence of pesticides on wildlife for the first time has been proved (C. Rachel, 1964).

In 80th of the last century in the world appeared technologies of gene engineering which have found at once the place in agricultural industry of the USA, and then and in others states. Genetic engineering of plants is growing rapidly. The first genetically modified plants were received in 1984. After two years in the U.S. and France have already conducted field trials, and in 1996 began to grow crops on a commercial scale. The new technology allows to set the necessary properties to any organism or a plant, to do by its more resistant to environmental conditions, to pests, to change the form and colour, to increase periods of storage of a product and many other things. In many cases, the use of transgenic plants significantly increases productivity.

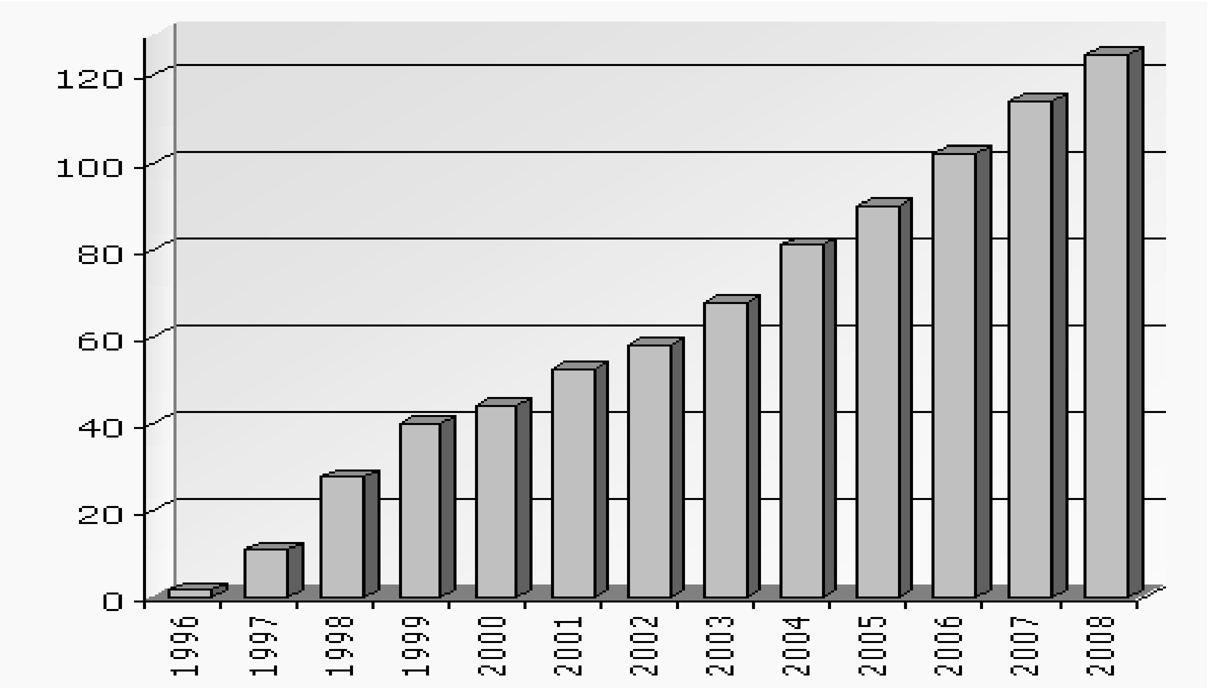


Figure 1.1 Area sown plants with altered DNA

World area sown plants with altered DNA in 1996 increased by 50 times, and today make up more than 100 million hectares (Fig. 1.1).

According to official figures, GMOs are contained in virtually every ten products sold in Russia. According to unofficial - in some regions they are part of third, and even half of the food.

Annually in the country in the form of raw materials imported 500 thousand tons of GM ingredients from the USA, Brazil, Argentina and China. By means of gene engineering cultivate a soya, corn, a rape. GM ingredients are added to sausage, ice cream, chocolate, sour cream, bread and even baby food.

Introduction to agriculture of synthetic fertilizing, pesticides and technologies of gene engineering have been directed on a hunger solution of a problem in the world at the expense of increase of production of food stuffs and their reduction in price. However completely solve a task in view they could not, as till now the world about 15 % of the population lack food stuffs.

Now there are many discussions about safety of use of transgene plants and animals in agriculture (В. Лебедев 2003, О.А. Монастырский, 2004). According to the international concern Monsanto, a leader in genetically modified plants by genetic engineering methods, to date there is no scientifically confirmed case of the negative effects of transgenic plants on human health, despite nearly 20-year history of use in the U.S. and other developed countries. However, many experts believe that it was still not enough time in order to be able to draw definitive conclusions about their safety, it is possible that the negative consequences will affect future generations.

The struggle of humanity for improving agricultural productivity in the XX century came to a dangerous level. Increasing a person's ability to control and change nature can turn against man. One of the laws of the American biologist and ecologist B. Commoner (1974) states: "Nature knows best"; scientist warns of need for careful management of natural systems. New agricultural technology is able to permanently alter the ecosystem and disrupt the natural connection. Existing examples of manifestations of the problems of modern methods of food production indicate that people increasingly are forced to think about the quality of food consumed.

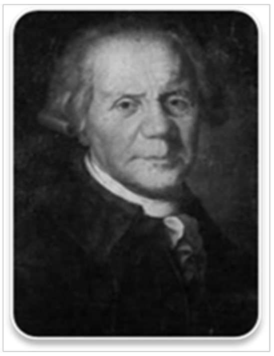
Some innovations may give rise to the emergence of other innovations. A striking example of this in agriculture is that in response to the spread of chemical fertilizers, pesticides and genetic engineering technology, systems of «sustainable» agriculture began to appear.

In developed countries, where the consumer has the financial ability and is willing to pay for their health and environmental safety of the planet, has been actively developing a new line, called "organic farming". There were also such systems close to organic agriculture as Permaculture and Low External Input Agriculture (LEIA), sales of products Fair Trade quickly increase.

Thus, environmental problems and hazards to human health through consumption of food was the reason for the active development of a new trend, called "organic farming"

1.2 History of organic agriculture

The idea of ecological agriculture is not new; it has the roots in proceedings of classics of a domestic agricultural science. The founder of a domestic agronomic science A.T.Bolotov (1738-1833) in 1771 in work «About division of fields» has formulated main principles of agroecology - agricultural industry conducting in harmony with the nature. It was the first handbook in Russia on the organization of agricultural terrain by introduction of crop rotations. Its idea and practical recommendations are used abroad by production of biologically high-grade and healthy production.



Bolotov A.T.
(1738-1833)

The writer, the memoirist, philosopher, the botanist and the forester. One of agronomics founders in Russia.

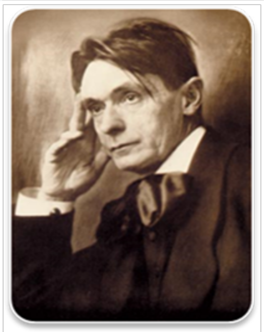
In Russia the fund of a name of A.T.Bolotov have been created, The main objective - support of scientific researches in the field of ecology and biology of the Russian agriculture.

Ecology questions receive the further development in of works of I.M.Komov (1750-1792), A.V.Sovetov (1826-1901), A.N.Engelgart (1832-1893), P.A.Kostychev (1845-1842), V.V.Dokuchayev (1846-1903), I.A.Stebut (1833-1923), etc.

In the thirties last century academician V.R. Williams had been offered a grassland agriculture system which will in many respects be coordinated with principles of organic agricultural industry if to take into consideration landscape the approach to application of the given system that has not been made. However, conducted from the early 60's policy of intensive agriculture has led to significant displacement of the views of these scientists on agricultural production in our country.

In Germany in the 20th years of last century, develops biodynamic farming as an early and still current version of the organic agriculture. Theoretical positions biodynamic farming were developed by Austrian scientist R. Steiner - founder of anthroposophy. The biodynamic direction considers all alive as well balanced whole in scales not only terrestrial, but also space interrelations. It starts with recognition of influence of the Moon and asters on development of plants, binding it to position of heavenly bodies. In practical terms, its basic principles is to perform all the agricultural operations in accordance with natural and cosmic rhythms and the use of biodynamic preparations and materials for the care of plants, composting of manure and other organic waste.

Steiner's followers joined in the «trial circle», which was banned from coming to power of Hitler However, the top of Nazi Germany showed a very high interest in organic production. On the basis of the SS was not even created a special body dealing with food supply. For his work personally answered Himmler, chief of the SS and one of the founders of organic agriculture in the concentration camp at Dachau.



Steiner R.

(1861-1925)

According to the theory of biodynamic farming to support the action of cosmic forces on the plant and the plants themselves allow special biodynamic preparations, which are derived from certain parts of plants (yarrow, chamomile, oak bark, flowers of valerian). The important role is assigned to biodynamic composts for which preparation also use biodynamic preparations. All actions for soil fertilizing are directed on creation of soil fertility "corresponding to the nature". Principles of biodynamic agriculture are taken as a principle drawing up of lunar calendars for crop of crops which are popular at market gardeners.

In the scientific literature there are many critical remarks concerning biodynamic agriculture. They pay attention to insufficient experimental confirmation of theoretical postulates of this direction and great difficulties in achievement on the basis of biodynamic agriculture of the same yields, as well as at traditional agriculture.

Currently approximately 1% of U.S. OFs are certified Biodynamic by the Demeter certification label (Mendenhall 2001).

The social and practical groundwork for the modern OA movement was laid in the 1940's in publications by Albert Howard in the UK. He has spent long time in India as the adviser concerning agricultural industry. Investigating aboriginal means of agriculture, he has come to a conclusion that they it is better offered by an official agricultural science. For progressive ideas and offers on enriching of agrarian production he has deserved a title of the father of modern organic farming. His book «An Agricultural Testament», left in 1940, has had huge influence on many scientists and farmers. Howard has described negative influence of agricultural chemicals on health of animals and a plant, has offered the fertilizer system of soils which is based on use of composts from plant residues and manure.

Howard A.

(1873-1947)

His book, "The agricultural covenant» (An Agricultural Testament), published in 1940, has had a huge impact on many scientists and farmers. Howard described the negative effects of chemical fertilizers on the health of animals and plants, proposed a system of fertilization based on the use of compost from crop residues and manure.

In 1939, Eve Balfour (Eve Balfour) influenced by the works of Howard puts the world's first science experiment on agricultural lands in the UK to compare conventional and organic agriculture. 4 years later she released her book «The Living Soil». This work has been widely disseminated and led to the establishment of one of the most famous institutions today on organic agriculture - Soil Association.

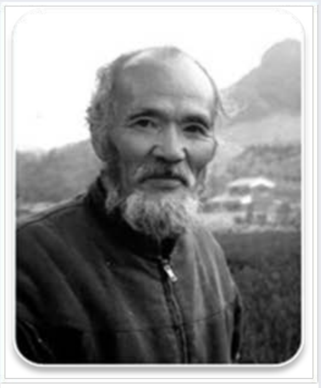
In the United States in 1943 by Louis Bromfield (Louis Bromfield) publishes his book «Pleasant Valley», which describes his experience in the agricultural state of Ohio, USA. Bromfield was an active supporter of the agricultural practices that promote soil conservation, as well as supporting most of the ideas of Howard. In the book "Malabar Farm," published in 1948, Bromfield described his experience of organic agriculture on his farm.

However, the most powerful carrier of new ideas in the U.S. was Jerome Irving Rodale. Rodale was one of the first who popularized the term «organic agriculture». In 1942 he founded the magazine «Organic farming and gardening». In 1950, Jerome Irving Rodale founded another magazine – «Prevention», which set out the philosophy of organic agriculture. In 1954, edition Rodale headed son - Robert Rodale. Unlike his father, who made emphasis on the fact that organic products are most useful for health, Robert Rodeyl also considered social and environmental benefits of these products. In 1971 Robert founded the Rodale Research Center, which is now called the Rodale Institute of Experimental Farming.

In Switzerland, Hans and Maria Mueller were pioneering organic farming techniques. Herr Mueller was encouraged by the biodynamic agriculture of Steiner and developed the «organic- biological» farming method in the 1950s.

Hans-Peter Rusch, a medical doctor, microbiologist and good friend of Hans provided the scientific basis for Hans's work in his book Boden- fruchtbarkeit (Soil Fertility) that linked soil microbiology with fertility. This movement became more formalized in the 1970s with the adoption of the trade mark Bioland, now the largest certifier in Germany.

In Japan, organic farming started to develop about 100 years ago. An important contribution to its development, introduced Japanese philosopher Mokichi Okada. Particular attention he paid to the so-called «Nature Farming», principles which largely correspond to the modern organic farming.



Fukuoka M.

(1913-2008)

On the farm in Japan more than 40 years were engaged in cultivation of rice and mandarins. According to Fukuoka the natural farming does not need neither machines, nor in pesticides, in fertilizings and demands a weeding minimum. By the time of a writing of the well-known book «Revolution of one straw» in 1975 the soil on a farm was not treated 25 years, thus fertility did not drop, and grain yields approached to record for industrial field cropping of Japan.

Japanese farmer Masanobu Fukuoka refers to the founders of «organic agriculture» as well. He was born in 1913. Fukuoka has practiced at his farm, a new method of farming, which he called «do-nothing». His most famous books are «The Natural Way of Farming» and «One Straw Revolution».

By the end of 1940, there are organisations developing organic farming, such as Soil Association in Great Britain, Rodale's publishing house in the USA, and Bioland organic label in Germany.

The first use of the term «organic farming» was in 1940 by Lord Northbourne in his book Look to the Land Land (A. M. Scofield 1986). Northbourne used the term not only in reference to the use of organic materials for soil fertility, but also to the concept of designing and managing the farm as an organic or whole system, integrating soil, crops, animals, and society. This systemic approach is at the core of OA today (N. H. Lampkin and S. Padel, 1994) and is fundamental to understanding the decisions of the OA community, such as its opposition to transgenic crops and foods, its discomfort with mainstream commercialization, and its recent steps toward inclusion of social and ethical issues in OA.

One of the most common directions of development of organic farming has become a «permanent agriculture».

Permaculture is an approach to designing human settlements and agricultural systems that are modeled on the relationships found in natural ecologies. It uses traditional farming methods, and modern science and technology. The uniqueness of this approach is that after the establishment of the ecosystem for its operation does not require intense physical labor and additional fertilizer.

As an example of an ideal closed-loop system is a forest or a swamp in which there are many plants and animals, and their functioning of the place without human assistance, fertilizers and of agricultural machinery, etc. If you find and properly distribute useful relations between plants and animals, you can create a similar high-performance closed system in agriculture. However, permaculture - is largely a philosophy of agriculture. There is no certification system, and farmers are working on enthusiasm.

The period between 1980 and 1990 saw a great revival in organic agriculture, initiated by environmental problems caused by modern agricultural practices. Organic agriculture was attributed to be sustainable and environmentally friendly and was redefined as «ecological» agriculture or «ecoagriculture». The image of organic agriculture as a problem-solver attracted much larger groups of

In the mid-1970s, Australians Bill Mollison and David Holmgren started to develop ideas about stable agricultural systems in Tasmania, Australia. This was a result of rapid growth of destructive industrial-agricultural methods. They saw that these methods were poisoning the land and water, reducing biodiversity, and removing billions of tons of topsoil from previously fertile landscapes. They announced their permaculture approach with the publication of Permaculture One in 1978. The term permaculture initially meant "permanent agriculture" but was quickly expanded to also stand for "permanent culture" as it was seen that social aspects were integral to a truly sustainable system.

The International Federation of Organic Agriculture Move-ments (IFOAM) is the world-wide umbrella organization for the organic agriculture movement, uniting more than 750 member organizations in 108 countries

«green» supporters, who made a political case for public support.

Since 1990, «green» and other political parties have initiated a number of activities promoting organic agriculture, such as ear-marked research grants, creation of research foundations and funding of university departments of organic agriculture. Furthermore, subsidies for organic production, educational programmers and extension services for organic agriculture were established. In several countries in Europe, organic agriculture has grown in the past 20 years to be a significant sector within agricultural production, whereas in other countries it has remained at a relatively low level. In Austria, for example, 200 farms were managed according to organic principles in 1980 and 18 360 in 2001, the latter accounting for approximately 25% of Austrian arable land. In Sweden, a political program with the aim of increasing organic production to cover 20% of farmland and to encourage the consumption of organically grown food in schools, hospitals, residential care homes etc. has recently been proposed. Today, organic agriculture is a mainstream interest in Western societies, although it has been criticized for not taking into account contradictory evidence regarding some of its claims (H. Kirchmann, et al., 2008).

Table 1.1 Summary of characteristics of the schools of organic agriculture

Founders and organisation	Philosophy and view on nature	Reasons for exclusion of synthetic fertilizers and pesticides
R Steiner (1861-1925); Biological dynamic farming	Anthroposophy; «Forces» in nature provide salvation	Artificial materials disturb the «flow of forces» in nature and destroy the «spiritual quality» of crops
A Howard (1873-1947); E Balfour (1899-1990); Soil Association	Nature romanticism; Undisturbed nature embodies harmony. Humus guarantees soil fertility providing health. Health is a birthright	Humus is the most significant of all nature's reserves. Inorganic fertilizers speed up humus decay
H-P Rusch (1906-1977); Biological organic farming	Eco-philosophy; Nature is a perfect unit with parity between all forms of life	Inorganic fertilizers are not adapted to the demand of crops. Diseases and pests are natural destruction processes
International Federation of Organic Agriculture Movements (since 1972); (IFOAM)	Environmentalism; Nature is the master	Organic practices are superior and therefore self-evident

Source: H. Kirchmann, et al., 2008

Table 1.1 provides a brief description of most propagation of schools, developing the idea of organic agriculture. One of the most influential organizations in the development of the direction of the movement is International Federation of Organic Agriculture Movements (IFOAM).

In 1972, the International Federation of Organic Agricultural Movements (IFOAM) was founded to represent the common interests of the different schools of organic agriculture but still allow their specific practices. This resulted in a new image of organic agriculture with less emphasis on methods but with a greater focus on aims. Today, the views and ideas of the founders of organic agriculture are regarded as history. It is believed that modern organic agriculture has progressed and bypassed the old schools (H. Kirchmann, et al., 2008). However, such a direction as biodynamic agriculture is developing quite successfully and has supporters around the world.

1.3 Definitions and terms of organic agriculture

Definitions of organic agriculture are similar worldwide and focus on ecological principles as the basis for crop production and animal husbandry. According to the National Organic Standards Board USA, organic agriculture is: «An ecological production management system that promotes and enhances biodiversity, biological cycles and soil biological activity. It is based on minimal use of off-farm inputs and on management practices that restore, maintain and enhance ecological harmony» (ATTRA 1995).

A more detailed description of what constitutes organic practices follows in the review of the 2000 USDA National Organic Program (NOP). As per the definition of the USDA study team on organic farming «organic farming is a system which avoids or largely excludes the use of synthetic inputs (such as fertilizers, pesticides, hormones, feed additives etc) and to the maximum extent feasible rely upon crop rotations, crop residues, animal manures, off-farm organic waste, mineral grade rock additives and biological system of nutrient mobilization and plant protection».

The term organic is also a labeling term that denotes products that have been produced in accordance with organic standards throughout production, handling, processing, and marketing (FAO 2000). The terms «biological agriculture» and «nature farming» are interchangeable with OA in Europe and Japan, respectively.

Definitions of OA are increasingly including social and ethical issues, i.e. fair labor practices, family farm viability, and animal ethics (IFOAM 2001).

Organic agriculture is a production system that sustains the health of soils, ecosystems and people. It relies on ecological processes, biodiversity and cycles adapted to local conditions, rather than the use of inputs with adverse effects. Organic agriculture combines tradition, innovation and science to benefit the shared environment and promote fair relationships and a good quality of life for all involved (IFOAM 2008).

In another definition FAO (Food and Agriculture Organization) suggested that «Organic agriculture is a unique production management system which promotes and enhances agro-ecosystem health, including biodiversity, biological cycles and soil biological activity, and this is accomplished by using on-farm agronomic, biological and mechanical methods in exclusion of all synthetic off-farm inputs».

According to terminology of the International organization of the United Nations on the foodstuffs and agriculture FAO (Food and Agriculture Organization), «Organic agriculture is a holistic production management system which promotes and enhances agro-ecosystem health, including biodiversity, biological cycles, and soil biological activity. It emphasizes the use of management practices in preference to the use of off-farm inputs, taking into account that regional conditions require locally adapted systems. This is accomplished by using, where possible, agronomic, biological, and mechanical methods, as opposed to using synthetic materials, to fulfill any specific function within the system».

In various countries to identify agricultural practices that meet the principles of organic agriculture, using different terms:

- Organic farming (agriculture), England, USA, Ukraine
- Biological agriculture - Austria, Germany, Georgia, Switzerland, Italy, France
- Natural farming – Finland
- Ecological agriculture - Sweden, Norway, Denmark, Spain
- Non-polluting agriculture – Estonia.

Organic product, produced in the EU.

Under the sign on the label should be the code controlling authority and place of cultivation of agricultural raw materials from which these products are produced, the name of the certification authority.

On 07/01/2010, in effect takes a single mark of conformity of the EU. To move to a uniform system of marking producers set aside a period of two years.

National Organic Program USA (NOP) certifies and monitors organic producers. Labeling requirements of NOP apply to raw, fresh processed products that contain organic agricultural ingredients.

In 2000, Japan implemented the standards for organic vegetable pro-duction. Only in November 2005, entered into force on organic stan-dards for livestock products and their processing.

Organic products have a special marking. In the countries where there is a market of organic production use of such words as «organic», «eco», «bio», «nature» and any other concepts which invoke in the consumer association with organic production, separately or in word combinations it is possible only if the given product meets the requirements of the organic legislation and its production is certificated as organic.

An important factor in the rapid and successful development of organic agriculture is the activities of national associations of producers of organic agricultural products. Germany is a major

European country by the manufacturer of such products. The largest association of German at the present time - Demeter, Bioland, Naturland, whose demands are much higher and stricter than the requirements of the EU organic production.

According to EU standards, the term «ecological», «biological» and «organic» agriculture is virtually synonymous. IFOAM uses the term «organic farming» or «organic agriculture», a Russian translation of official documents of the organization, he translated as "organic agriculture". The publications in Russian often use the term «organic farming».

Demeter - a brand product of bio-dynamic farming. Exists since **1924.** Currently, Demeter International has 16 member organizations from Europe, America, Africa and New Zealand. Thus Demeter-International is more than 4200 manufacturers in 43 countries.

Logo of the largest associations in Germany, founded in **1971**, is the highest standard of quality organic products and is more stringent than national standards.

However, in our opinion the term organic agriculture should be distinguished from ecological agriculture. In this case, organic agriculture will be part of the ecological agriculture, where a strictly prescribed conditions for conducting business activities, which are enshrined in various standards (ATTRA, IFOAM, Bioland, etc.). Ecological agriculture is a more flexible term that allows depending on the prevailing conditions (soil, climate, etc.) to simu-late activity which will be based on ecological and economic suitability. Ecological agriculture should involve the use of an integrated approach in terms of economic activity, which provides a sustainable development of rural areas. In other words, organic agriculture should not exclude, for example, the use of chemical fertilizers or pesticides, if it makes certain ecological suitability.

However, therein lies the problem. Ecological agriculture is difficult to regulate because of the large variability of soil and climate, socio-economic and other conditions. Even harder to control his conduct. In this regard, organic agriculture has certain advantages, because based on the standards, followed by control measures.

As for the legislation of the Russian Federation is still at the state level are not fixed concepts of «ecological», «bio-logical», «organic».

Quite often organic products name «ecologically pure products» that is true, but only partially because the mentioned term does not display the complex approach. Ecological compatibility is only one of advantages of bioorganic production, but by no means unique. While in some countries, such as the Netherlands, Norway, Spain, organic products are usually called «eco» products.

As to the legislation of the Russian Federation that According to Additions and changes № 8 to SanPiN 2.3.2.1078-01"Hygienic requirements of safety and food value of food products" from

2008 to food produced with the use of technologies for their production from raw materials produced without pesticide application and other security facilities of plants, chemical fertilizers, growth stimulants and animal feed, antibiotics, hormones and veterinary drugs, GMOs have not been subjected to treatment using ionizing radiation and in accordance with these Regulations (hereinafter - the organic foods), sets out the information: «Organic product».

For the production of crops and plants, livestock, poultry and beekeeping, produced using technologies that manufacture food from raw materials produced without pesticides and other pesticides, chemical fertilizers, growth stimulants and animal feed, antibiotics, hormones and veterinary drugs, GMOs, and not subjected to treatment using ionizing radiation, as well as processed products containing in its composition at least 95% ingredients derived from the requirements of these Regulations, and the contents of the other ingredients in the final product does not exceed 5% the mass of all ingredients (except salt and water) (hereinafter - the organic foods) are used:

- agricultural fields, land, lots, farms for which the transitional period of not less than two years from the time of planting or in the case of perennial crops (excluding grass-lands crop) of at least three years before the first harvest of organic products;
- only natural flavours;
- preparations of microorganisms and ferments that are allowed in accordance with established procedure used in food processing or as process aids, with the exception of genetically modified micro-organisms or enzymes produced by genetic engineering.

Sometimes it is possible to meet opinion that for Russia it is necessary to think up cardinally other name to the given kinds of products. For example, A.J.Mazurova (2009) suggests to use the term «bioorganic agriculture» and «bioorganic product».

In countries where there is a market for organic products there are some differences in what foods should be called «organic». So in the U.S. there are four categories of products depending on the content of organic ingredients (Fig. 1.1).

The first category includes products for 100% consisting of organic ingredients. On their packaging, respectively, written 100% of organic and there is a sign of organic agriculture in the USA.

The second group includes products in which 95-99% by weight (excluding water and salt) are organic ingredients. On their packaging it is written "organic" and there is a sign of organic agriculture USA.

If the organic ingredients of 70-90%, then the package is allowed to write "Made with Organic", but on packaging it is forbidden to put a sign on organic agriculture of the USA.

On products where contains less than 70 % of organic components in the USA it is impossible to write on face sheet a word "organic", however, if the given product nevertheless contains organic components they can be listed on the back party of packaging

Figure 1.2 Categories of products depending on the content of organic ingredients in USA

In Europe, there are three categories of «organic» products:

1. If the product consists of 95-100% organic ingredients, it is called organic;
2. If the product consists 70-94% organic ingredients, the word "of organic" can only be used in the list of ingredients;
3. In the presence of at least 70% organic ingredients in the product, the word "organic" may not be listed on the packaging.

1.4 Advantages of organic agriculture

It became now obvious that the economic well-being reached at the expense of degradation of environment, threatens existence of the person as biological species, to its physical and mental health and, especially, health of the future generations. In this situation the person has a unique exit - to find stable equilibrium between economic well-being and conservation of safe inhabitancy for it and to leave on a sustainable development trajectory. The organic agriculture gives such possibilities. If it is short, the basic advantages of organic agriculture concerns:

- the best taste;
- environmental conservation;
- increase biological diversity;
- safety for animal and human health, because Organic products contain no pathogens, parasites, GMOs and allergic components.

Food and Agriculture Organization mark out following advantages from the ecological point of view at transition to organic agriculture:

Sustainability over the long term. Many changes observed in the environment are long term, occurring slowly over time. Organic agriculture considers the medium- and long-term effect of agricultural interventions on the agro-ecosystem. It aims to produce food while establishing an ecological balance to prevent soil fertility or pest problems. Organic agriculture takes a proactive approach as opposed to treating problems after they emerge.

Soil. Soil building practices such as crop rotations, inter-cropping, symbiotic associations, cover crops, organic fertilizers and minimum tillage are central to organic practices. These encourage soil fauna and flora, improving soil formation and structure and creating more stable systems. In turn, nutrient and energy cycling is increased and the retentive abilities of the soil for nutrients and water are enhanced, compensating for the non-use of mineral fertilizers. Such management techniques also play an important role in soil erosion control. The length of time that the soil is exposed to erosive forces is decreased, soil biodiversity is increased, and nutrient losses are reduced, helping to maintain and enhance soil productivity. Crop export of nutrients is usually compensated by farm-derived renewable resources but it is sometimes necessary to supplement organic soils with potassium, phosphate, calcium, magnesium and trace elements from external sources.

Water. In many agriculture areas, pollution of groundwater courses with synthetic fertilizers and pesticides is a major problem. As the use of these is prohibited in organic agriculture, they are replaced by organic fertilizers (e.g. compost, animal manure, green manure) and through the use of greater biodiversity (in terms of species cultivated and permanent vegetation), enhancing soil structure and water infiltration. Well managed organic systems with better nutrient retentive abilities, greatly reduce the risk of groundwater pollution. In some areas where pollution is a real problem, conversion to organic agriculture is highly encouraged as a restorative measure (e.g. by the Governments of France and Germany).

Biodiversity. Organic farmers are both custodians and users of biodiversity at all levels. At the gene level, traditional and adapted seeds and breeds are preferred for their greater resistance to diseases and their resilience to climatic stress. At the species level, diverse combinations of plants and animals optimize nutrient and energy cycling for agricultural production. At the ecosystem level, the maintenance of natural areas within and around organic fields and absence of chemical inputs create suitable habitats for wildlife. The frequent use of under-utilized species (often as rotation crops to build soil fertility) reduces erosion of agro-biodiversity, creating a healthier gene pool - the basis for future adaptation. The provision of structures providing food and shelter, and the lack of pesticide use, attract new or re-colonizing species to the organic area (both permanent and migratory), including wild flora and fauna (e.g. birds) and organisms beneficial to the organic system such as pollinators and pest predators.

Genetically modified organisms. The use of GMOs within organic systems is not permitted during any stage of organic food production, processing or handling. As the potential impact of GMOs to both the environment and health is not entirely understood, organic agriculture is taking the precautionary approach and choosing to encourage natural biodiversity. The organic label therefore provides an assurance that GMOs have not been used intentionally in the production and processing of the organic products. This is something which cannot be guaranteed in conventional products as labelling the presence of GMOs in food products has not yet come into force in most countries. However, with increasing GMO use in conventional agriculture and due to the method of transmission of GMOs in the environment (e.g. through pollen), organic agriculture will not be able to ensure that organic products are completely GMO free in the future. A detailed discussion on GMOs can be found in the FAO publication "Genetically Modified Organisms, Consumers, Food Safety and the Environment".

Ecological services. The impact of organic agriculture on natural resources favours interactions within the agro-ecosystem that are vital for both agricultural production and nature conservation. Ecological services derived include soil forming and conditioning, soil stabilization, waste recycling, carbon sequestration, nutrients cycling, predation, pollination and habitats. By opting for organic products, the consumer through his/her purchasing power promotes a less polluting agricultural system. The hidden costs of agriculture to the environment in terms of natural resource degradation are reduced. A recent publication by Jules Pretty: "The Real Costs of Modern Farming" examines many of these issues in greater detail.

Today organic farming is a rapidly developing area of business. Global sales of organic products in the last ten years have increased tenfold. In Europe more than 10 percent of all agricultural land is cultivated under organic culture.

In 2010 market cost of organic products and drinks has on a global scale compounded about 59,1 billion dollars, mainly due to growing demand in North America and Europe. The organic agriculture is applied in 160 countries of the world on 37,2 million in hectare of agricultural land. The number of farms engaged in organic farms close to 2 million. And these figures are not only result of subsidies for development of an organic direction, and the serious proof of augmentation of interest to this point in question from sociability. For our country it should be of great importance, because the popularity of the rural lifestyle is one of the lowest in Europe. Organic agriculture can change existing for decades, the negative trends and lay the foundations for sustainable development of rural areas.

The wide experience in this direction is saved up by foreign countries. In particular: the development of agro-tourism, the establishment of Agro Hotels, where the practice of healthy lifestyles, consumption of organic food, etc.

Organic agriculture can be regarded as one of the elements of innovation development because the market is introduced products with new consumer properties (organic products). Besides, it helps to diversify the market of agricultural production.

1.5 The productivity of conventional and organic systems

Food production is coupled to a moral imperative, as sufficient food supply is a cornerstone of human welfare. Development of agricultural practices ensuring food sufficiency is a basic human requirement, a prerequisite for satisfactory social conditions and a necessity for civilisations to flourish. Lack of food, on the other hand, is a tragedy leading not only to suffering and loss of life but also to inhuman behaviour, political instability and war (N.E. Borlaug, 1970). In fact, eradication of famine and malnutrition has been identified as the most important task on Earth (UN Millennium Project, 2005).

Public perception of the term «organic» connotes concern for product safety, healthfulness, and environmentally sustainable production (T. Bruulsema, 2003). Very often it is possible to meet opinion that transition to organic production of crops is accompanied insignificant or even by absence of reduction of productivity, therefore organic production of crops can feed the world. There are recent claims that sufficient food can be produced by organic agriculture, expressed in terms such as «organic agriculture can feed the world» (L. Woodward, 1995; A. Leu, 2004; C. Badgley and I. Perfecto, 2007). The following three arguments have been put forward:

1. Lower production of most crops can be compensated for by increased production of legumes, in particular of grain legumes, while a change to a diet based mainly on vegetables and legumes will provide enough food for all (L. Woodward, 1995).

2. Realities in developing countries must be taken into account: 'Increased food supply does not automatically mean increased food security for all. Poor and hungry people need low-cost and readily available technologies and practices to increase food production» (J.N. Pretty et al., 2003).

3. «Organic agriculture can get the food to the people who need it and is there-fore the quickest, most efficient, most cost-effective and fairest way to feed the world» (A. Leu, 2004).

According to J.N. Pretty et al. (2003) due to large-scale introduction of organic agriculture is possible to solve the problem of hunger in Africa.

However, the demand for food, feed and fibres will greatly increase during coming decades (FAO, 2007) driven by a growing population, which is getting wealthier. The global human population has doubled over the last 40 years, to around 6.5 billion people in 2006, and food plus feed production has tripled during the same period (FAO, 2007). By 2030, the global population may reach 8-9 billion, of which 6.8 billion may live in developing countries (J. Bruinsma, 2003; Geo-Hive, 2007). As the projected increase will mainly take place in developing countries, Africa would need to increase food production by 300%, Latin America by 80%, Asia by 70%, but even North America by 30%. Assuming that the additional population consumes only vegetarian food, a minimum of 50% more crops will need to be produced by 2030 to ensure sufficient food supply. As a satisfactory diet has been defined to consist of 40 g animal protein per person and day and taking into account that diets throughout the world are changing with the rise in income towards more meat and dairy products irrespective of culture, there will be a need to actually increase food plus feed production by 60 to 70%. Since the largest proportion of the projected increase is expected to come from pork, poultry and aquaculture, meeting future demand will depend on achievable increases in cereal yields (G.E. Bradford, 1999). A doubling of cereal yields may be necessary by 2030.

Global food production increased by 70% from 1970 to 1995, largely due to the application of modern technologies in developing countries, where food production increased by 90%. However, global food production must grow to the same extent in the coming three decades, as pointed out above, to meet human demand (J. Bruinsma, 2003; K.F. Cassman et al., 2003; B. Eickhout et al., 2006). Two principal possibilities for achieving this increase have been identified: intensifying agricultural production on existing cropland or ploughing up natural land into cropland, i.e. clearing pastures and rangelands, cutting forests and woodland areas, etc.

A fundamental question is whether organic yields can be increased radically or whether more natural ecosystems have to be converted into cropland. The following four observations indicate that intensification rather than area expansion is necessary:

- agricultural land is steadily decreasing as it is being taken over for urban or industrial use;

- global warming may reduce the potential for higher yields in large parts of the world (M. Parry and et al, 2005.);
- significant areas of farmland may be used for fuel production, competing with food production (S. Nonhebel, 2005);
- cropland simply cannot be expanded, due to shortage of suitable land.

In the prevailing conditions, a particularly acute problem is estimating the productive capacity of organic and conventional systems.

According to L. Bergstrom (2008), organic agriculture cannot feed the world, because there is substantial scientific evidence that crop yields are considerably lower in organic systems. The long-term yield reduction could be as much as 40-50% compared with the corresponding conventional crops.

Therefore, to obtain equivalent yields in organic systems, significantly more land would be needed for agricultural crops. However, according to recent assessments, such land is not available in the world. It is worthwhile mentioning that most good agricultural soils are already under cultivation and that additional crop production would have to use soils of low fertility or with a high risk of erosion or other degradation processes when cropped.

A 40% yield reduction in developed countries would require 67% more agricultural land to produce the same amount of crops (H. Kirchmann et al., 2008). This does not take into account future population growth, which will primarily occur in developing countries where the situation regarding crop production is already critical in many cases. In a world perspective, population growth is expected to be 50% within the next couple of decades. Crop production in developing countries is largely limited by the lack of artificial fertilizers, water and crop protection strategies. In those systems, crop yields can only be increased by providing such inputs and methods. In this context, it is worth mentioning that a key conclusion presented at the FAO meeting in Rome 2008 by the Secretary General of the UN was that one of the most important ways out of starvation in developing countries is increased use of artificial fertilizers (H. Kirchmann and et al., 2008).

Irrespective of the different situations prevailing in developed and developing countries, there is no doubt that when considering the population growth aspect and applying only organic production methods, land demand for crop production would increase considerably.

Thus, when discussing the various forms of crop production (conventional or organic) should be borne in mind that determining the value will have systems that ensure food safety as it is now, and in the future. Therefore, organic agriculture should not be regarded as the only alternative to the traditional agriculture. Sustainable agriculture should combine a variety of shapes and organic direction should be considered as an important but not the only component. Though, as we have already found out, here it is possible to meet set of gamble that can cause serious failures.

Developing the concept of organic agriculture must take into account the fact that simplification cannot guarantee a solution to all problems, including environmental ones. Organic production should also include responsibility for solving these problems.

In this regard, the concept of organic agriculture should be defined taking into account generalization of scientific and practical experience, without misleading public.

1.6 Organic farming methods

Different types of sustainable agriculture technologies have emerged as opposed to «green revolution». However, the conversion to organic agriculture does not mean simplification, and does not necessarily exclude an integrated approach to solving problems by using modern instruments, but only introduces some limitations. Often simplified understanding of these problems can undermine the efforts to promote the production of organic forms of management and may cause a backlash, which will be characterized by negative environmental and economic consequences. Therefore in this question it is very important to be defined with real possibilities of use of various methods of conducting organic agriculture, and also their efficacy in the various it is soil-environmental conditions.

In a short form, development of methods of organic farming can be considered from two parties: reductions of use of synthetic fertilizers, plant protection in modern agriculture, on the one hand, and integration of modern ecological understanding with conventional methods on the other hand.

The method of organic agriculture is based on two main points:

- Tendency as much as possible to use natural biological processes.
- Do not harm the environment (mainly due to reduction of agricultural chemicals, and more rational use of natural resources).

The main methods of organic farming are:

- Crop rotation,
- Application of organic fertilizers, including straw and green manure crops,
- Control of weeds, pests and diseases using biological methods,
- Mechanical cultivation,
- Selection of plant varieties and animal breeds, bred by breeding rather than genetic engineering

Methods of organic agriculture are directed on conservation of natural state of soils and maintenance of their fertility at the expense of entering of organic fertilizers, practically a complete elimination of synthetic fertilizers, herbicides, and pesticides. For pest control are applied biological methods, as well as the widely used crop rotation effect. As to animal husbandry, here are forbidden concentrates, hormones, treatment is carried out without the use of antibiotics. Based on the foregoing is possible to draw the following conclusions and mark out the main differences between organic agriculture and conventional:

1. The organic agriculture is directed on conservation of natural ecological balance in the nature;

2. Maintaining the health of soil, plants, animals, humans, planets in general is the main purpose of organic agriculture;

3. In view of limitation of natural resources the organic agriculture shows the economic attitude to the nature by means of the closed production cycle;

4. Organic Agriculture cares about the present and future generations,

5. Rejecting the applications of genetic engineering, synthetic additives, dyes, fertilizers at all stages of the production and processing.

All these features are summarized in four principles of organic agriculture and environmental management, formulated IFOAM.

1.7 Principles of organic agriculture

To understand the motives for the transition to organic farming, its methods and outcomes, it is important to understand the guiding principles of organic agriculture. These principles cover the main objectives and warnings, which are considered important for the production of high quality food, fiber and other goods in an ecologically sustainable environment. Principles of organic agriculture have changed with the development of the organic movement, although formulated were not so long ago. Throughout most of history organic farming, the principles are unwritten; they have been installed in the philosophy and practice of different schools.

IFOAM has been a key organization defines principles of organic agriculture. Initially, these principles have been established in 1980. In consequence, they have changed and are now presented as follows:

- The principle of health
- The principle of ecology
- The principle of fairness
- The principle of care

Principles of organic agriculture (organic farming and organic animal husbandry) are universal for all countries, cultures and forms of ownership and size of organic production. These principles adopted by International Federation of Organic Agriculture Movements (IFOAM).

The principles are applicable to agriculture in the broadest sense and include the methods by which people take care of the land, water, plants and animals for the production, processing and distribution of food and other goods. They relate to the ways people interact with the natural landscape, coupled with each other and protect the heritage for future generations.

Principle of health

Organic Agriculture should sustain and enhance the health of soil, plant, animal, human and planet as one and indivisible.

This principle points out that the health of individuals and communities cannot be separated from the health of ecosystems - healthy soils produce healthy crops that foster the health of animals and people.

Health is the wholeness and integrity of living systems. It is not simply the absence of illness, but the maintenance of physical, mental, social and ecological well-being. Immunity, resilience and regeneration are key characteristics of health.

The role of organic agriculture, whether in farming, processing, distribution, or consumption, is to sustain and enhance the health of ecosystems and organisms from the smallest in the soil to human beings. In particular, organic agriculture is intended to produce high quality, nutritious food that contributes to preventive health care and well-being. In view of this it should avoid the use of fertilizers, pesticides, animal drugs and food additives that may have adverse health effects.

Principle of ecology

Organic Agriculture should be based on living ecological systems and cycles, work with them, emulate them and help sustain them.

This principle roots organic agriculture within living ecological systems. It states that production is to be based on ecological processes, and recycling. Nourishment and well-being are achieved through the ecology of the specific production environment. For example, in the case of crops this is the living soil; for animals it is the farm ecosystem; for fish and marine organisms, the aquatic environment.

Organic farming, pastoral and wild harvest systems should fit the cycles and ecological balances in nature. These cycles are universal but their operation is site-specific. Organic management must be adapted to local conditions, ecology, culture and scale. Inputs should be reduced by reuse, recycling and efficient management of materials and energy in order to maintain and improve environmental quality and conserve resources.

Organic agriculture should attain ecological balance through the design of farming systems, establishment of habitats and maintenance of genetic and agricultural diversity. Those who produce, process, trade, or consume organic products should protect and benefit the common environment including landscapes, climate, habitats, biodiversity, air and water.

Principle of fairness

Organic Agriculture should build on relationships that ensure fairness with regard to the common environment and life opportunities.

Fairness is characterized by equity, respect, justice and stewardship of the shared world, both among people and in their relations to other living beings.

This principle emphasizes that those involved in organic agriculture should conduct human relationships in a manner that ensures fairness at all levels and to all parties - farmers, workers, processors, distributors, traders and consumers. Organic agriculture should provide everyone involved with a good quality of life, and contribute to food sovereignty and reduction of poverty. It aims to produce a sufficient supply of good quality food and other products.

This principle insists that animals should be provided with the conditions and opportunities of life that accord with their physiology, natural behaviour and well-being.

Natural and environmental resources that are used for production and consumption should be managed in a way that is socially and ecologically just and should be held in trust for future generations. Fairness requires systems of production, distribution and trade that are open and equitable and account for real environmental and social costs.

Principle of care

Organic Agriculture should be managed in a precautionary and responsible manner to protect the health and well-being of current and future generations and the environment.

Organic agriculture is a living and dynamic system that responds to internal and external demands and conditions. Practitioners of organic agriculture can enhance efficiency and increase productivity, but this should not be at the risk of jeopardizing health and well-being. Consequently, new technologies need to be assessed and existing methods reviewed. Given the incomplete understanding of ecosystems and agriculture, care must be taken.

This principle states that precaution and responsibility are the key concerns in management, development and technology choices in organic agriculture. Science is necessary to ensure that organic agriculture is healthy, safe and ecologically sound. However, scientific knowledge alone is not sufficient. Practical experience, accumulated wisdom and traditional and indigenous knowledge offer valid solutions, tested by time. Organic agriculture should prevent significant risks by adopting appropriate technologies and rejecting unpredictable ones, such as genetic engineering. Decisions should reflect the values and needs of all who might be affected, through transparent and participatory processes.

2 Soil management in organic agriculture

2.1 The concept of soil fertility

It should come as no surprise that many cultures have considered soil central to their lives. After all, people were aware that the food they ate grew from the soil. Our ancestors who first practiced agriculture must have been amazed to see life reborn each year when seeds placed in the ground germinated and then grew to maturity. In the Hebrew Bible, the name given to the first man, Adam, is the masculine version of the word «earth» or «soil» (adama). The name for the first woman, Eve (or Hava in Hebrew), comes from the word for «living». Soil and human life were considered to be intertwined. A particular reverence for the soil has been an important part of the cultures of many civilizations (F. Magdoff, 2009).

Although we focus on the critical role soils play in growing crops, it's important to keep in mind that soils also serve other important purposes. Soil properties influence whether rainfall runs off the field or enters the soil and eventually helps recharge underground aquifers. When a soil is denuded of vegetation and starts to degrade, excessive runoff and flooding are more common. Soils also absorb, release, and transform many different chemical compounds. For example, they help to purify wastes flowing from the septic system fields in your back yard. Soils also provide habitats for a diverse group of organisms, many of which are very important - such as those bacteria that produce antibiotics. Soil organic matter stores a huge amount of atmospheric carbon. Carbon, in the form of carbon dioxide, is a greenhouse gas associated with global warming. So by increasing soil organic matter, more carbon can be stored in soils, reducing the global warming potential. We also use soils as a foundation for roads, industry, and our communities.

The doctrine of the fertility of arable lands and its reproduction - the theoretical basis of scientific farming.

In process of accumulation of data on soil representation about soil fertility differed also. In ancient times people idolised soil fertility, as the sun, fire and water. First, they explained the presence of the fertility of the soil «fat» or «vegetable oil», then - the water, humus (humus) or mineral nutrients, and finally began to associate it with a set of soil properties.

In the definition of «soil fertility» helped A. Thaer, J. Liebich, I. V. Dokuchaev V. R. Williams, A.A. Rode,V.A. Kovda, I.S. Kaurichev, I.V, Tyurin and other scientists.

According to modern representations soil fertility, is ability of soil to provide plants with terrestrial factors of life and to yield a harvest (i.e. to provide with nutrients, air and water, to form congenial soil acidity and contain no toxic substances).

However, the above definition does not take into account the important elements that characterize the stability of the agroecosystem in time and opportunity to obtain safe for human health foods.

According to GOST 16265-89. Soil Fertility - a set of soil properties, providing the conditions necessary for plant life.

On the other hand there may be fertile soil exposed to radioactive contamination? The growth and development of plants, the assimilation of nutrients from the soil and formed the harvest will be adequately fit the definition of fertile soil. However, the products obtained from such soil will be toxic to humans.

In this regard, the definition of soil fertility should read as follows:

> ***Soil fertility*** *is the capacity of the soil on the basis of its properties serve as a habitat for plants and be a source and a mediator in the use of terrestrial life factors for the production of environmentally safe products (yield).*

Production is environmentally safe products will depend on the ability of soil to withstand external shocks related primarily to human activities. To do this, the soil should be a central element in determining the stability of agroecosystem.

From this point of view of idea and organic farming principles are more full entered in system defining maintenance and increase of soil fertility.

Fertility indexes are divided into three major groups:

- Biological indicators of soil fertility;
- Agrophysical indicators of soil fertility (Soil physical properties);
- Agrochemical indicators of soil fertility.

For each of these groups there are methods of soil improvement (influence):

- Biological methods of influence;
- Agrophysical methods of influence;
- Chemical methods of influence.

Application of organic farming imposes certain limitations on use of these methods. The basic accent in organic farming is made on biological methods of influence: crop rotation, the seeding technique, use of phytophags etc. Application of chemical methods of influence on soil fertility (synthetic fertilizers, pesticides, etc.) isn't supposed. As to agrophysical methods of influence on soil fertility, the highest attention it is given to soil cultivation and means of reduction of mechanical influence on soil.

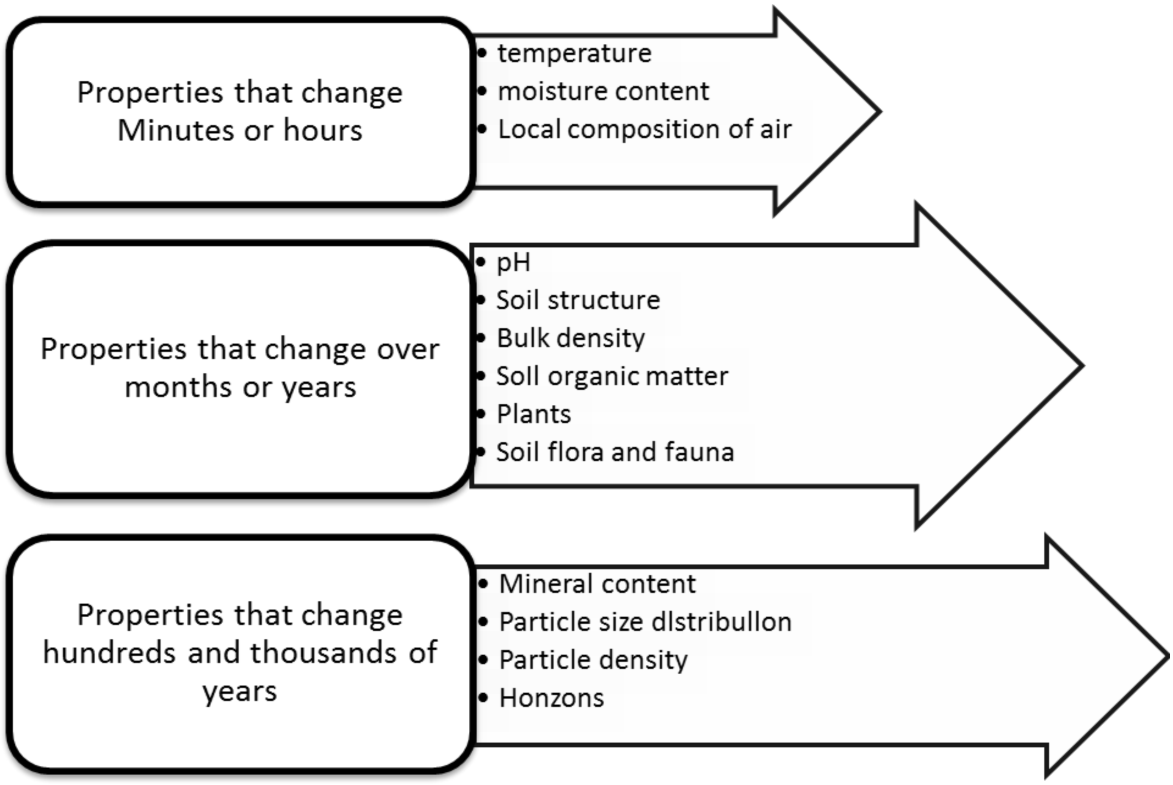


Figure 2.1 Soil Properties That Change Over Time (C. Jhonson, 2009)

For the maintenance and reproduction of soil fertility is necessary to know the structure of soil fertility, ie, its properties, based on which will be the overall management of growth, development of crop plants and obtain environmentally safe food products.

Optimization of soil physical properties - an important part of a shared problem of optimisation of inhabitancy of crops. Figure 2.2 presented their brief classification.

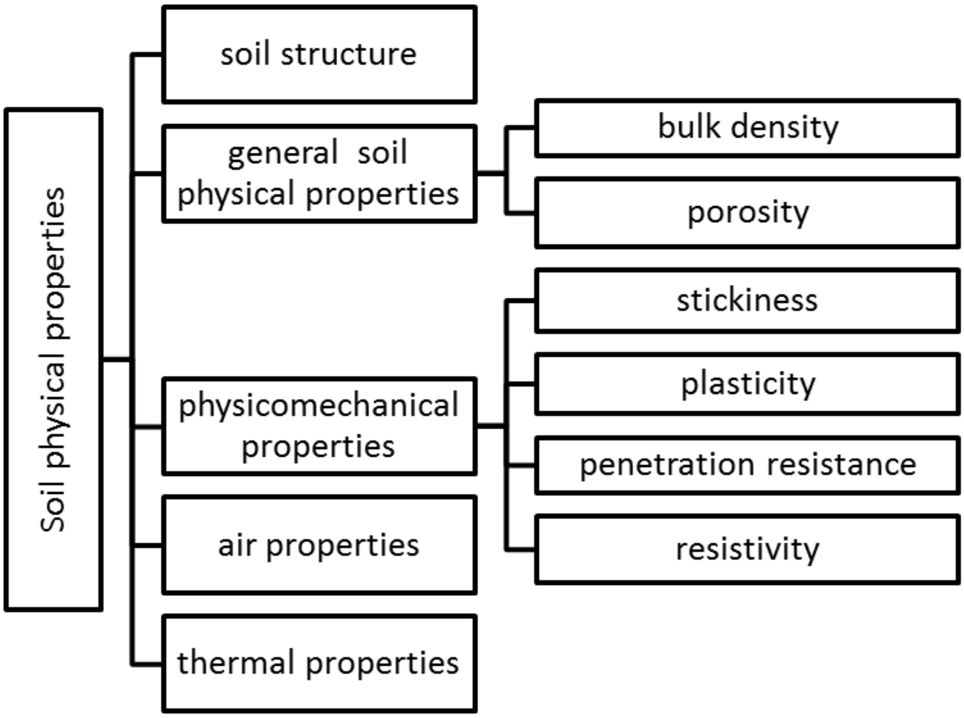


Figure 2.2 Soil physical properties (Short classification)

In the given work we do not put a problem studying of agrophysical indicators of fertility and means of their control. This is a rather ambitious goal, requiring a fundamental knowledge in this area. Therefore, the main emphasis will be placed on those indicators that should be considered in the transition to organic farming.

Among the most significant indicators of Soil physical properties is the soil structure.

Soil structure is one of the most important indicators of the physical condition of the soil (Н.А. Качинский, 1947; А.Д. Воронин, 1986 В.В. Медведев, 1988, Е.В. Шеин, 2005). It creates the optimal conditions for water, air, heat and nutrient regimes that affect seed germination of plants, growth and spread of roots in soil.

According to Н.А. Качинский (1963) to deny the importance of soil structure - means to deny the importance of all physical properties of the soil closely bound to structure.

In a science long time has been extended representation about soil structure only as about its ability to form «aggregate» from elementary soil particlesAt the same time, the soil is like any other object is characterized by multiple levels of structural organization:

- molecular-ion level;
- level of elementary soil particles;
- aggregate level;
- epipedon level,
- level of the soil individual;
- soil cover level.

In other words – structureless soils do not exist. The concept «structureless soil» was generated when the science level of development did not allow an intrastructural explanation when at the morphological description of horizons applied a visual estimate. That is why the term «soil structure» was identified with its aggregate. Among the structural components of the soil - this aggregates composition.

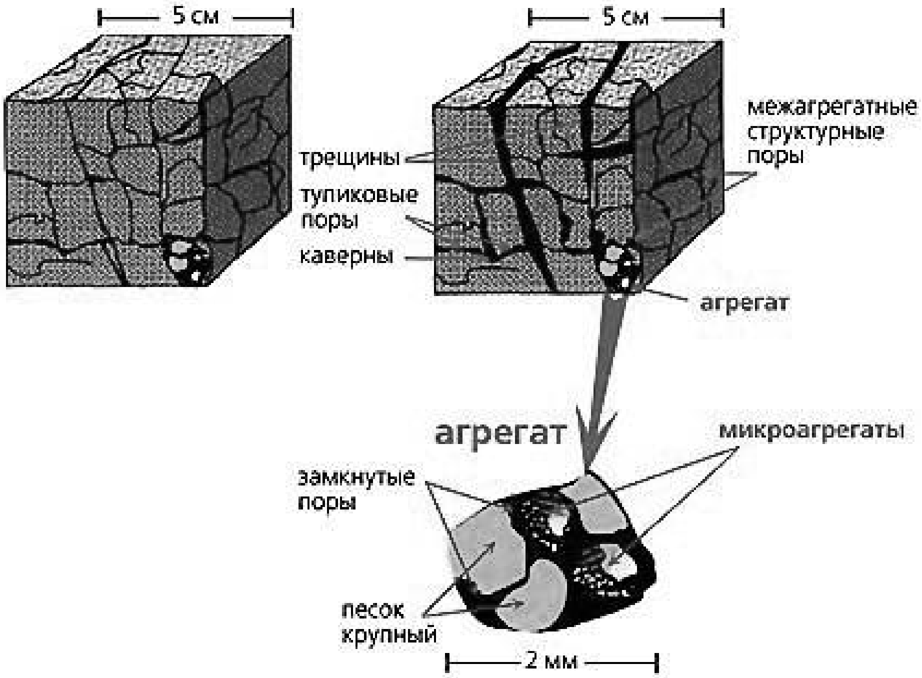


Figure 2.3 The scheme of soil macroaggregate > 0,25 mm

Since the end of the XIX century Е. Вольни (1896) found that valuable aggregates are lumps of soil aggregates from 0.25 to 10 mm. In turn, the soil consisting of aggregates smaller than 0.25 mm is structureless. According to the А.Д. Воронин (1986) with the agronomic point of view should be considered the most valuable aggregates the size of 0,25 to 5 mm. Plough layer, consisting of such aggregates, has the most optimal space structure of the pores, combining a relatively large interaggregation pores, which are filtered water into the soil and the gas exchange takes place, with a significant amount of average pore size, mostly holding and conducting of soil water.

The main causes of the destruction of soil structure adopted to group:

- physical (effect of tillage, soil moisture, the change of the temperature, etc.);
- physico-chemical (related to exchange reactions between cations in the soil);
- biological (associated with microbial activity in soil, which is responsible for mineralization of soil organic matter).

It is important to understand that traditional agriculture can also be based on ecological trailers at the expense of decrease mechanical action on the soil, the rational use of synthetic fertilizers and maintain a positive balance of organic matter.

***Soil structure** is the arrangement of soil particles into secondary units called aggregates or peds. Soil aggregates can be characterized in terms of their shape (or type), size (fine, medium, or coarse), and distinctness (or strength, such as strong, moderate, or weak).*

Effect of conventional and organic systems on soil structure basically is a possibility and the limitation of using different methods. And it is assumed that organic farming is less destroys the structural aggregates (Table 2.1).

Table 2.1 The main causes of the destruction of the soil structure

Causes of the destruction of the soil structure	**Conventional agriculture**	**Organic agriculture**
Soil tillage	Is one of the main reasons for the destruction of soil structure	Tillage should be held on the basis of minimization (energy saving)
The use of synthetic fertilizers	Negative impact on the soil structure appears at high burrowing making synthetic fertilizer (especially nitrogen)	Synthetic fertilizers are not used
The negative balance of soil organic matter	Due to specialization of production and a reduction in the structure of sown areas of crops with high yield of crop residues, low economic efficiency of the use of organic fertilizers	The negative balance of organic matter - is unacceptable. Solve the problem due to organic fertilizers, green manure, crop rotation.

It is important to understand that traditional agriculture can also be based on ecological trailers at the expense of decrease mechanical action on the soil, the rational use of synthetic fertilizers and maintain a positive balance of organic matter. This system in this respect can even be called a more flexible, compared to organic systems. In turn, organic agriculture, in principle, preclude the degradation of soil structure through the use of organic fertilizers (compost, green manure), crop rotation, etc.

Ways to improve soil structure in organic agriculture, though are in many respects similar with conventional, but all the same have also differences (Table 2.2.).

Table 2.2 Ways to improve soil structure

Ways to improve soil structure	**Conventional agriculture**	**Organic agriculture**
1. The use of organic fertilizers	+	+
2. The joint use of organic and synthetic fertilizers	+	-
3. Tillage at the optimum soil moisture	+	+
4. Minimizing tillage	+	+
5. Use of pesticides to reduce mechanical tillage	+	-
6. Introduction to the crop rotation of perennial grasses, cover crops	+	+
7. Making artificial of structure-forming	+	+

The general physical properties of soil also are the major characteristics of its physical state. With their change water, air and thermal soil characteristics change В.И. Макаров, Ф.И. Грязина, В.Г. Кириллов, 2008). Special attention here should be given to the density of the soil.

Very loose soil because of the diffuse draining plow layer does not provide the normal water regime for vegetative plants. On dense soils the air regime is broken, the root system badly inpours into deep layers that leads to decrease in productivity of crops.

In Agrophysics distinguish two densities:

- The density of soil solid phase - depends on the density of its constituent particles of minerals and their relationships, as well as on the amount of organic matter. Typically, the density of the mineral soil horizons ranges from 2,4-2,8 g/cm^3 and organogenic from 1,4 to 1,8 g/cm^3 (peat). The density of the upper soil horizons on the average 2,5-2,6 g/cm^3, lower - 2,6-2,7 g/cm^3.
- Soil bulk density - one of the major properties defining ability of soil to pass and keep a moisture, air to resist to tools of soil cultivation and etc. Soil bulk density depends on the type of vegetation, mechanical and mineralogical composition of soil (dispersion), addition, soil structure and of soil management.

According to theoretical calculations of the Soil bulk density dependence of the packing aggregates and to study the reactions of plants on the bulk mass of soil have been formulated on the optimal position for the plants and the equilibrium for the soil bulk density (И.Б. Ревут, Н.А. Соколовская, А.М. Васильев, 1971).

The equilibrium soil bulk density is formed when the soil is not treated within 2-3 years. (Б.А. Доспехов, 1976).

The optimum soil bulk density it not a constant, and a range of values at which is reached the highest yield of field crops (И.Б. Ревут, Н.А. Соколовская, А.М. Васильев, 1971, В.В. Медведев, 1990).

The value of the optimum soil bulk density of the topsoil of different soil types from sandy to clay texture according to various researchers in the range of 1 to 1.4 g/cm3 (И.В. Кузнецова, 1990).

The range of optimum values of soil bulk density is enough dynamical magnitude, i.e. variates depending on a soil type, soil structure, crops, the season of vegetation, moisture, nutrition (В.В. Медведев, 1990).

Building a system of tillage should take into account the optimum parameters of soil bulk density.

Physico-mechanical properties of the soil reveal themselves when exposed to external loads.

Such physicomechanical properties as stickiness, plasticity of soil allow to define optimum time for soil cultivation when it is in a state of physical maturity and breaks up to aggregates at me-

The density of soil solid phase - *is the ratio of the mass of the solid phase to the mass of water at the same level at +4 ° C.*

Soil Bulk Density - *the bulk density of a soil is the mass of dry soil per unit of "bulk" (total volume of soil or soil particles & pore space).*

chanical influence of tools of tillage. And penetration resistance and specific resistance provide guidance on to force which is spent by roots of plants and the tool of tillage passing through soil.

Very important properties of soils are biological. They are sensitive ecological and agronomic indicators of man impact. They include both in the conventional agriculture and the particular importance they acquire in the organic agriculture, where these and properties are the basis for sustainable development of the system (G. LeGuillou, A. Scharpe, 2000).

Among biological indicators of soil fertility are the following:

- Content and composition of organic matter (humus)
- Biological activity of soil - a complex of microbialogic processes proceeding in soil and their intensity (allocation CO2 from a soil surface, decomposing cellulose) etc.
- The number and composition of the various groups of microorganisms (especially the presence of nitrogen-fixing and nitrifying bacteria).
- Number and composition of beneficial soil insect fauna.
- The degree of contamination of soil with seeds and vegetative organs of reproduction of weeds. Presence in it of pathogens and pests.

Organic matter plays an important and multifaceted role in the creation of soil fertility is its integral indicator. Up to 90% of the total stock of organic matter in soil is humus, which is represented by a group of high-molecular compounds of different chemical nature (Д.Г. Звягинцев и др., 2005).

Humus is involved in all phases of soil formation: the formation of the soil profile, creating water-stable structure, improving aeration, increase water-holding capacity, regulation of nutrient and microbial regimes (Р. Тейт, 1991; А.В. Литвинович, О.Ю. Павлова, 2007).

Biological activity of soil is particularly important during the transition to environmentally friendly, organic farming methods. Indicators of biological activity - soil respiration, enzyme activity, the structure of microbiota, the rate of decomposition of cellulose, provide valuable information on specific environmental conditions of soil environment (Ю.Г. Гельцер, 1990).

Carbonic gas formation in soil is closely bound with biological and a biochemical process proceeding in it; therefore intensity of its release is widely used as a biological activity indicator at an assessment of fertility of soils, so-called «soil breath».

Depth of setting and distribution of crop residues and straw in the treated soil layer at Primary tillage has a significant impact on biological processes. When placing the plant residues on the soil surface is decreasing soil biological activity: isolation of carbon dioxide from the surface by surface placement of crop residues is minimal, if termination of crop residues in the 0-7 cm layer slightly increases soil respiration, and sealing them deeper 7 cm, and increases rate already at 20-35% (В.М. Гармашов и др., 2007).

Enzymatic activity accurately and faithfully reflects the biological properties of soils and their changes under the influence of anthropogenic factors. Thus, the intensity and direction of change dynamics of humus in the soil depend on the enzymatic activity, particularly redox enzymes: catalase, peroxidase, polyphenol oxidase.

Catalase is one of the test enzymes that are present in almost all soil microorganisms. Catalase decompose toxic to cells, hydrogen peroxide, formed during respiration of living organisms and as a result of various biochemical oxidation of organic substances into water and molecular oxygen.

Increased catalase activity is observed when introducing straw (В.И. Барейша, Р.Р. Вильдфлуш, 1980), and long-term systematic application of herbicides leads to its (A.E.Smith, 1991).

Cellulose - the most common carbon compound in nature, the synthesis of its scale ranks first. Its basically create higher plants. Synthesis of cellulose is associated with its decomposition by microorganisms. With this process due to the formation of soil humic substances and the formation of soil structure (И.П. Бабьева, Г.М. Зекова, 1989).

Processes of cellulose decomposition in the soil allow to judge on bioclimatic and ecological conditions of soil formation, the intensity of biochemical processes, biological cycling of elements of nutrition and good living conditions of cellulolytic microorganisms are close to optimal for growing field crops. Therefore, biological activity, defined by the rate of decomposition of cellulose, accurately reflects the range of soil conditions, which acts on the major integrated indicator of soil fertility - crop yield (В.П. Манжосов, В.Н. Маймусов, А.М. Чигаев, 1993).

Mineralization of cellulose is carried out by different groups of bacteria, fungi and actinomycetes, are actively producing the enzyme cellulase (О.А. Берестецкий, Ю.М. Возняковская, Л.М. Доросинский, 1984).

The higher their activity, the faster by the biological cycle of elements and the more fully cultivated plants provide nutrients (А.П. Лазарев, Ю.И. Абрашин, Л.Л. Гордеюк, 1997).

Living organisms - a mandatory component of the soil. Number of them in a well-cultivated soil can reach several billion in a gram of soil, and total weight - up to 10 tonnes / ha.

The bulk of living organisms - *microorganisms*. The dominating role belongs to the plant microorganisms (bacteria, fungi, algae, actinomycetes). Animal organisms are protozoa (flagellates, rhizopods, ciliates), and worms. Quite common in the soil are snails and arthropods (spiders, insects).

Soil organisms decompose dead plant and animal residues in soil. One part of the organic matter is mineralized completely, and the products of mineralization assimilated by plants, while the other goes in the form of humic substances and living bodies of soil organisms.

Some microorganisms (free-living and nodule nitrogen-fixing bacteria) absorb atmospheric nitrogen and enrich with it soil. Therefore, the selection of crops, contributing to the exacerbation of symbiotic nitrogen fixation, is essential (M.H. Ryan, J.H. Graham, 2002; P. Marschner, Z. Rengel, 2003).

Practical value has ability of some microorganisms to have ruinous an effect on representatives of a phytopathogenic microflora. Strengthen the activity of desirable microorganisms can be achieved by introducing into the soil organic matter. In this case, marked upsurge in the development of soil saprophytes, which, in turn, stimulate the growth of microorganisms that afflict phytopathogenic species. For the normal functioning of soil organisms are needed primarily energy and nutrients. For the vast majority of microorganisms such an energy source is the soil organic matter.

Microorganisms may have a positive impact on many soil properties: the decomposition of organic matter and crop residues, increasing the availability of plant phosphorus, manganese, zinc, copper, biological nitrogen fixation, plant growth (production of hormones for plant protection against root pathogens, increased efficient use of nutrients), biological protection from diseases of plants, soil nematodes; pests and weeds control; biodegradation of synthetic pesticides and pollutants, increased drought tolerance of plants, improvement of soil aggregation. However, the microbial community is constantly adapting to the changing environment and is therefore a sensitive indicator of soil quality (A.C. Kennedy, R.J. Rapendick, 1995).

Different agricultural practices - tillage, fertilizer, crop rotation, and others have a significant effect on soil microflora (Е.Н. Мишустин, В.Т. Емцев, 1978).

For example, a decrease in the intensity of tillage contributes to the cellulolytic activity of the arable layer (A.S. Franzluebbers, F.M. Hons, D.A. Zuberer, 1992; Т.В. Ласомова, 2002).

In this case, the activity of soil microflora is mainly dependent on the income or the presence of soil organic matter. Sources of organic matter in soil is manure, peat, straw, green manures, perennial grasses, cover crops (W. Jäggi, U. Walther, H.R. Oberholzer, 1993; А.И. Пупонин, Г.И. Баздырев, В.Г. Лошаков, 2000).

When mulching crop residues is also observed activation of microbiological activity in connection with an abundance of energy sources (J.E. Lloyd и др., 2002).

A special problem is the interaction of soil biota to pesticides. It has two aspects: the impact of pesticides on biota and degradation of pesticides under the influence of soil biota. Dangerous imbalance of microbial coenoses arises because of high concentrations of pesticides. Most susceptible to pesticides are microalgae, nitrifiers, microorganisms assimilating molecular nitrogen air, destructors, cellulose, symbionts (В.Г. Минеев, Е.Х. Ремпе, 1990).

For example, on chernozem soil herbicides (Glyphosate, Atrazine, etc.) reduce the amount of ammonifying, bacteria and fungi (B. Piskorz, 1998).

It testifies to defensible abandoning of application of pesticides in organic farming with a view of increase of microbiological activity of soil.

The presence of *earthworms* in the soil is one of the key indicators of ecological condition.

Under natural conditions on 1 hectare of a soil covering of earthworms is from several tens thousand to several millions, and their biomass reaches 2-4 tons.

Earthworms are not only bio-indicators, but also an important factor in improving soil fertility. Established that from a high population of earthworms (0,8-3 million pieces / ha) in the soil for the year comes easily digestible plant nutrients more than 80 tons per hectare. In addition, earthworms improve the aeration of the soil water regime and facilitate decontamination of soil and organic fertilizer from viruses (H. Ramseier, 1989; L. Amaravadi, M.S. Bisesi, R.F. Bozarth, 1990).

Earthworms are as important representatives of soil fauna beneficial effect on various parameters of the soil. Earthworms make tunnels in the soil and their excrements have a positive impact on soil structure and on the soil physical properties. In addition, there is a close link between the humus content, appearance and shape of organic matter and the number of earthworms. Development of a population of earthworms depends largely on the content of organic matter in soil, and their activities, in turn, affect the state of humus (Ф. Эллмер, С. Крюк, М. Ешко, 1996).

The number of earthworms in agricultural lands increases proportionally to the number of abandoned crop residues on the fields. Mulching soil with straw increases the number of earthworms in 2,5-4 times (Н.И. Картамышев, А.А. Тарасов, 1993).

Use of pesticides in agricultural lands is to reduce the number of species and a decrease in the number of earthworms (R. Viswanathan, 1989; M.G. Migranov, 1992; В.Ф. Мальцев, Н.М. Кувшинов, 1997).

The given findings are fair and for arthropods among which predatory ground beetles are frequently used not only as bioindicators of ecological well-being agricultural lands, but also as a control device of pests of cultivated plants (T. Basedowetal., 1976). It is very important, especially in organic agriculture, where insecticides are not applied. And at an organic farming quantity of predatory ground beetles and species diversity are often above, than at the conventional (H. Hokkanen, J.K. Holopainen, 1986; L. Pfiffner, 1990; B. Kromp, 1990).

And herbicides such as Glyphosate, Atrazine, Linuron, reduce the number of predatory arthropods (G.J. House, 1989; Г.А. Бурлака, Л.Н. Жичкина, 2008).

To some extent, soil dwellers can adapt to changing conditions of life or go to other parts of the field deep into the soil. But the high load, high concentrations of substances introduced into the soil inhibit or suppress soil biota (В.Ф. Мальцев, О.В. Торикова, 2000; В.В. Уваров, Г.Н. Ненайденко, 2004).

Phytotoxicity of soil caused by the accumulation of physiologically active substances, among which there are phenolic compounds, organic acids, aldehydes, alcohols and others. The totality of these substances was named colin, the composition and concentration of which depend on temperature and soil moisture on micro-organisms and plants. At low concentrations of phytotoxic substances in the soil revealed a stimulating effect, but an increase in their content comes strong inhibition of plant growth or seed germination. Source of formation and receipt of toxic materials in soil - root exudates of plants, postharvest plant residues and products of a metabolism of microorganisms. Most intensively phytotoxic substances accumulate in growing in the same place of homogeneous crops and to create in the soil anaerobic conditions. Thus, the decomposition of crop residues of grain crops in the soil revealed high content of phenolic compounds, which, being in the zone of plant seeds inhibit their germination.

Anaerobic conditions favor the formation of toxic substances, as root exudates and intermediate products of mineralization of humus are transformed into highly reduced compounds, which make the creation of centers of toxicity in the soil. It is possible to believe also that in the root zone of some plants to selectively accumulate certain groups of microorganisms that unfavourably effect on plants.

Phytotoxins soil micro-organisms cause changes in the chemical composition of plants, the metabolism in them. They affect the respiration rate, and the nitrogen metabolism of plants, reduce the photosynthetic activity of plants.Токсичность почвы могут вызывать и гербициды (И.В. Дудкин, 1998; А.А. Ищенко и др., 2006).

The biological properties of soil can also be attributed level of phytosanitary condition - disease prevalence and ***the potential contamination of soil with seeds and organs of vegetative propagation of weeds (seed bank)***, which is mainly regulated by mechanical action on the soil. Unequal action of different systems of soil cultivation on potential contamination of soil with seeds and organs of vegetative propagation of weeds is bound, first of all, to distinctions in a ploughing under of seeds both vegetative germs of weeds and their moving in a treated layer.

While minimizing tillage in soil layer focuses the bulk of viable weed seeds, which is one of the main reasons for the high infestation of crops (А.И. Пупонин, А.В. Захаренко, 1999).

Among the ***diseases*** of plants are the largest groups of pathogenic fungi. On leaves of infected plants can be observed for various types of mottle, incrustations, pustules, which consist of spores of the parasite, which are carried by wind to infect new plants. These lesions rarely cause the death of the plants, but reduced their productivity.

Cultural method of crop protecting traditionally refers to the fundamental ways of influence on agroecosystems, especially when excluding the use of pesticides, which is an integral hand-term organic farming.

Most representatives of a large group of land-air-organisms partially retain their link with the soil, mainly in the wintering period. They persist on plant debris on the soil surface. Method of soil treatment may interrupt the life cycle of pests, or impair the conditions of his passing, especially during winter.

However, not all agents of leaf-stem infections persist on plant debris. Examples are rust disease, wintering in the intermediate host. In this case degree of influence of a mean of soil cultivation much more low, in this case a biochemical compound of host plants will be more important. Less accumulation of nitrogen in the form of nitrate contributes to the suppression of the development of rust disease in comparison with plants, where nitrate levels above.

Essential for the normal functioning of the agricultural lands are agro-chemical indicators of soil fertility:

- pH soils;
- Presence in soil of nutrients, especially mobile forms of nitrogen, phosphorus and potassium. And for separate areas and presence of separate microelements.
- Number of absorbed bases, absorption capacity, availability of rolling AL.
- Presence in soil of heavy metals, radioactive nuclides.

For their growth and development of plants absorb nutrients from the soil in the form of mineral salts dissolved in soil solution.

One of the main indicators of soil fertility is the presence of available phosphorus and exchangeable potassium in it. Under the conditions of intensive farming their intake of fertilizers should not only reimburse the removal, but also create a reserve of available forms in soil (О.В. Сдобникова, 1985).

Phosphorus and potassium are essential elements for plant nutrition. In the vegetable organism takes a lot of physiological processes with their participation. In this regard the timely satisfaction of the needs of plants in phosphorus and potassium is one of the conditions of formation of high yields of crops (С.Н. Адрианов, Б.А. Сушеница, 2004).

Uptake by plants of nutrients, soil microbial activity, mineralization of organic matter, decomposition of soil minerals and dissolution of sparingly soluble compounds, coagulation and peptization colloids, and other physical and chemical processes to a large extent depend on the pH of soil. It also affects the efficiency of fertilizers applied to soils (Б.А. Ягодин, П.М. Смирнов, А.В. Петербургский и др., 1989). Increased acidity of the soil reduces the absorption of nutrients by plants.

Most of the crops and soil micro-organisms developed better in slightly acid or neutral soil. However, certain types of crops vary widely in exactingness to the pH.

Lack of soil exchangeable calcium and magnesium causes a sharp deterioration of the physical and physico-chemical properties of soil (soil structure, absorption capacity, buffering). In the soil solution appear free ions of aluminum and manganese that are toxic to plants. The mobility of the same number of trace elements (eg molybdenum) is reduced, the plants are experiencing a lack of them. Acidity inhibits soil organisms, particularly nitrifiers and nitrogen-fixing bacteria (free-living and nodule), soil fauna (earthworms, mites, springtails). In general, the biological activity of acidic soils is far smaller than the neutral.

To control the acidity of the soil applied chemical amelioration of soils (contribute to soil lime and gypsum). To improve the content of the soil, such vital elements as potassium, nitrogen and phosphorus, making synthetic fertilizer. Efficiency of fertilizer depends on soil and climatic conditions.

It should be noted that the methods of maintaining agro-chemical properties of soil in conventional farming is not suitable for organic (C.A. Watsonetal., 2002). In the system of organic farming the use of chemical fertilizers is eliminated. Thus the basic attention is given to organic fertilizers. First of all use collateral production of cultivated plants, green manure crops, dilate crops under the cultures, the pozhnivno-root residual abandoning more, introducing catch crops, and also lead a manure and other cattle-breeding fertilisers (Table 2.3).

Table 2.3 Sources of supply plants with nutrients in organic agriculture

Chemical element	**Sources of supply plants with nutrients**
Nitrogen	Nitrogen fixation, manure, compost
Phosphorus	Phosphates, bone meal
Potassium	ashes
Calcium, magnesium	limestone, dolomite

Source: В.Б. Минин, 2005

2.2 Soil organic matter as the integrated indicator of soil fertility

Among the compounds of carbon greatest role in soil formation and soil fertility is played by organic substances (Д.С. Орлов, 2005).

Soil organic matter has an impact on nearly all soil properties, although present in relatively small quantities. The typical agricultural soil organic content matter is from about 1% to 6%.

Organic matter - the totality of the organic compounds present in soils. This concept includes both organic debris (tissue of plants and animals, partly retain the original anatomy), and individual organic compound specific and nonspecific.

The main share in the composition of organic matter took humic substances. It also includes plant residues and soil flora and fauna.

The role of organic compounds is so large that the problem of soil organic matter has always been a central position in agricultural science and production. Content, and reserves of humus are among the most important indicators of the level of which depends on nearly all agronomically valuable properties of soils.

Fertile soil is the foundation of health of plants, animals and humans. A soil organic matter is an integral index of soil fertility.

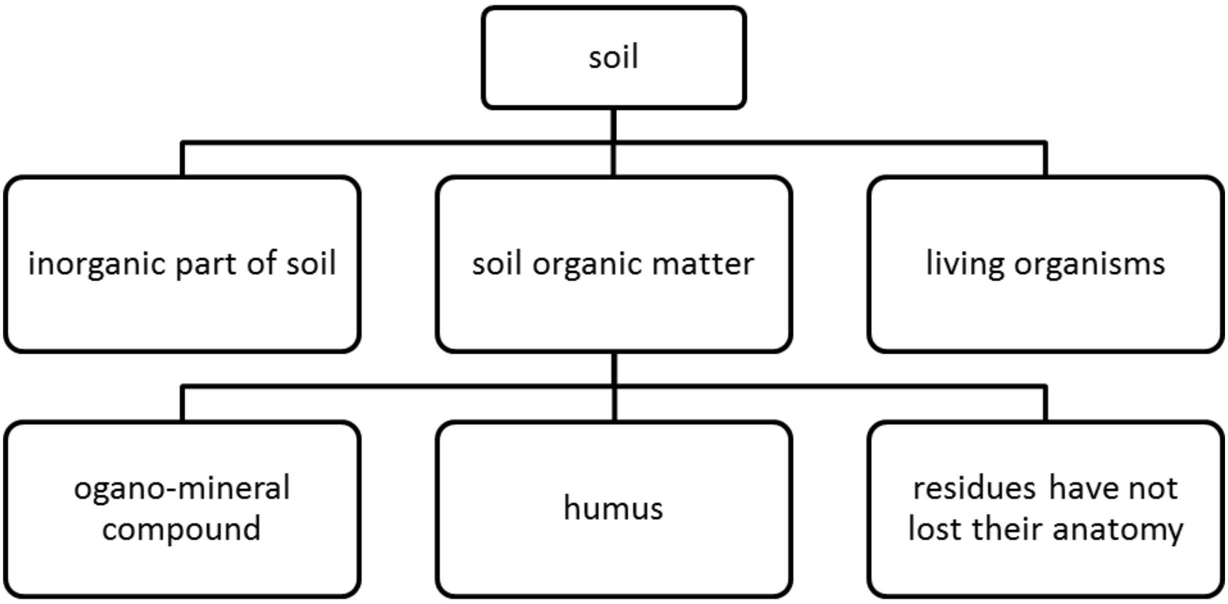


Figure 2.4 Nomenclature scheme of soil organic matter

Humus - the set of all organic compounds present in the soil, which are not part of the living organisms and have lost the anatomical features

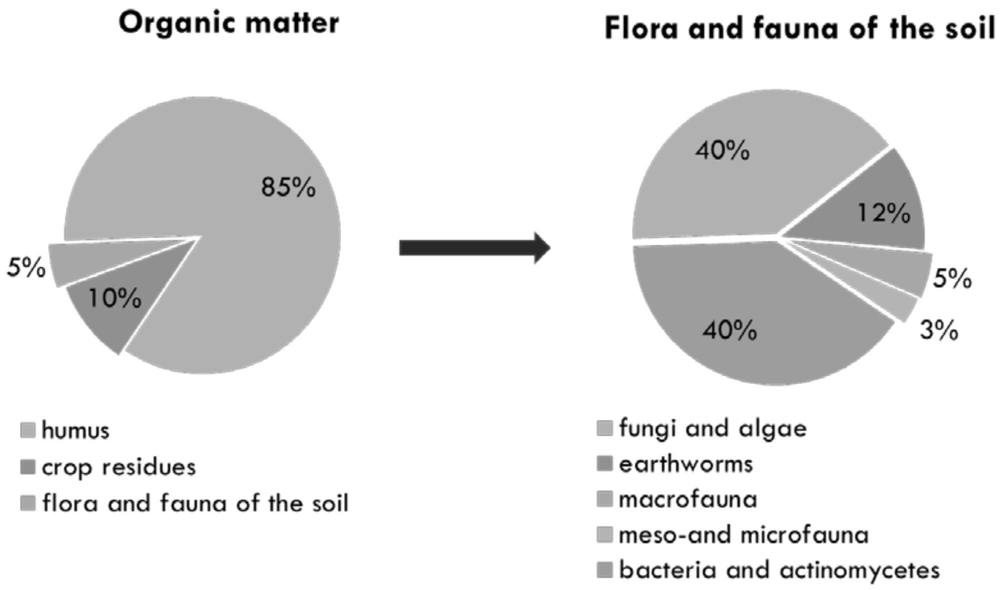


Figure 2.5 Average composition of soil organic matter (by D. Schroeder)

Understanding the role of organic matter in maintaining soil fertility is important for the development of organic agriculture. But how can an organic substance, which is only a small percentage of most soils, to be so important to determine the quality of the soil (health)? The reason is that organic matter has a positive effect, or change the effect of substantially all of the properties of the soil. And we must understand it to maintain soil fertility.

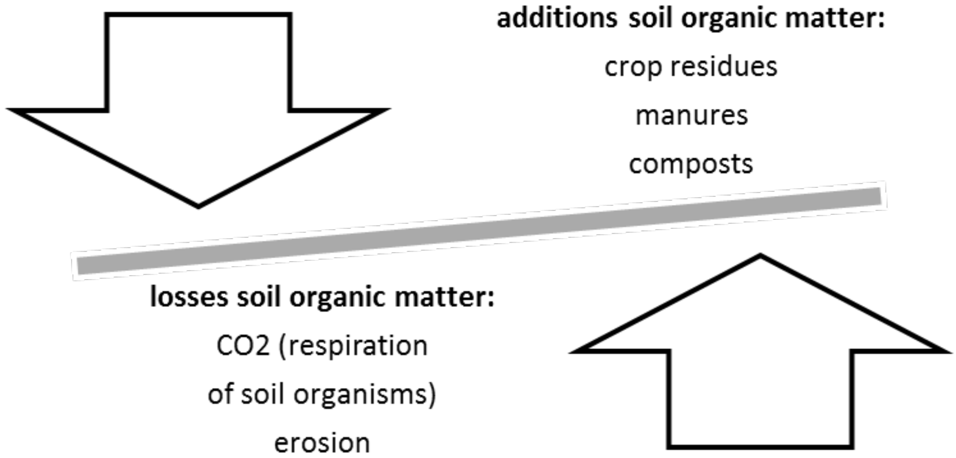


Figure 2.6 Additions and losses of organic matter from soils

The role of organic matter in soil fertility

1. Is a source of nutrients for plants (90-99% N, 80% sulfur, 60% P_2O_5, etc.). Performs accumulative function. Age GW can reach hundreds and even thousands of years.

2. Humic acids and their salts in very small concentrations has a stimulating effect on plants, increase the productivity of cows and poultry.

3. The main source of atmospheric CO_2 (7-10 times greater than the industrial discharge).
4. Improves agrophysical properties. Agrophysical properties of soil on 50 - 70 % are defined by the organic matter content.
5. Physico-chemical properties (absorption capacity, concentrations of soil solution) on 50 - 90% depend on organic matter content, because its sorption ability in 10 times more a mineral part.
6. Performs the function of the tread - the rich soil organic matter better resist drought or waterlogging, is less prone to erosion and deflation, can withstand higher anthropogenic load, reduce the toxic effects of heavy metals, binds strongly to radionuclides, pesticides, thus reducing their negative effect on plants and limit the vertical migration and contamination of groundwater.
7. Availability and quality of organic matter determine the biological properties of soil (nitrification capacity, the number of microorganisms and worms in the soil).
8. Determines soil regimes: water, air, thermal, nutrient.
9. Organic matter content determines the yield and quality of the crop (it is believed that the yield on 40 - 60% depending on the content of organic matter).

The main causes of loss of organic matter in arable soils

1. Reducing the number of plant residues entering the soil by changing the natural biocenosis by the agrocenosis.
2. Strengthening the mineralization of organic matter due to intensive treatment and aeration of the soil.
3. Decomposition and biodegradation of humus under the influence of physiologically acidic fertilizers, and enhance the microflora due to fertilizers.
4. Strengthening of mineralization due to drainage activities of wetland soils.
5. Strengthening the mineralization of humus mineralization of irrigated soils in the first years of irrigating. With long-term irrigation and high crop yields humus content in the coming years will stabilize or even rise.
6. Erosional losses of humus, which resulted in the humus content drops to as long as erosion is not stopped. The rate of absolute loss may gradually decline. Dimensions of erosion losses are large and may exceed the losses due to other causes.

2.3 Means of saving and improvement of soil fertility in conventional and organic farming

Conventional agriculture was formed under the influence of economic paradigm expressed by the German agronomist Thaer in 1810: "Agriculture - this occupation, which aims to make a profit or making money." The conventional structure of agriculture was able bear consequences of this paradigm up to 1960 x years, but then "specialisation", development of the animal husbandry torn off from land, overproduction of some products have cast agriculture into a whirlpool of ecological and financial problems. In Central Europe, the farm at 16 ha was barely able to feed one family, while in China in the same area can support themselves, along with 240 people belonging to them working cattle. The cause - a traditional Far East intense culture of soil which is based on humic and compost farm (О.Р. Молдаков, 1999).

Number one problem in agriculture in most countries of the world is the decrease of the natural fertility of soils. Type of reproduction of natural fertility and determines the type of eco-economic development of agriculture.

We can distinguish three types of reproduction:

- Incomplete, restricted reproduction of natural fertility, in which a decrease in natural fertility;
- Simple reproduction of natural fertility;
- Expanded reproduction of natural fertility.

The first type of reproduction of natural fertility corresponds to the type of anthropogenic development of the agricultural sector, the second and third - Sustainable Development.

In conventional agriculture produce, as a rule, there are three groups of methods of exposure (improvement) on soil:

a. Physical methods of improvement include all methods of cultivation soil, methods of regulation of thermal, water and air, nutrition, all kinds of reclamation and physical methods of creating the structure of the soil.

b. Biological methods of improvement include the regulation of the processes of synthesis and decomposition of organic matter in soil. Is effected by crop rotation, planting of perennial legumes, regulating the composition of the microflora, etc.

c. Chemical methods of soil improvement involve liming, gypsum, use of mineral fertilizers and micronutrient fertilizers.

Complex application of the given methods in conventional agriculture forms the system regulating indicators of soil fertility for the purpose of maintenance by terrestrial factors of life cultivated plants.

However, there are significant differences in outcomes and means of reproduction of natural and economic fertility. Orientation to reproduction (simple or dilated) only economic fertility can lead to the extremely unfavourable ecological and economic consequences. This is evidenced 20-30 years of experience in many areas of the former USSR. First, crop yield growth, and then its stabilization or reduction occurs at a significant increase in the use of artificial means of production and at the same time squandering of capital stock of soil fertility, accompanied by land degradation. Thus, attempts to compensate decrease in natural fertility by growth artificial are ineffective. In process of decrease in natural fertility, degradation of agroecosystems in many areas productivity of technique, fertilizers, pesticides becomes ever less.

An important stimulus search for a new model of agricultural production has been the widespread public awareness of the negative consequences that resulted in the exploitation of natural resources and environmental pollution, which affected the status of agro-ecosystems. Thus, began to develop soil erosion, sediment washed out of the fertile layer on the bottom of reservoirs, salinity and waterlogging, depletion of groundwater supplies. Poisoning of the environment remains of synthetic fertilizers and pesticides poses a direct threat to human health.

One of features of realisation of reproduction in agriculture is that crucial importance here has reproduction of natural biological system - lands, plants and animals. Therefore, in this branch of the economy the most important is to ensure unity of technology, biology, economics and ecology.

Conversion to organic agricultural production requires major structural changes. Simply reducing the intensity of use, or even eliminate the use of artificial products (fertilizers, pesticides), intensive tillage does not give the desired result. Any economic system must involve a complex where all of its elements are interrelated and interdependent.

The distinguishing feature of organic agriculture is to maintain soil fertility through enhanced biological methods of exposure.

Organic matter is the central element of organic production systems. Its content determines the development of the soil community by regulating nutrient, soil structure, and even resistance to many diseases, insects and weeds. There are fundamental differences in the biological, chemical and physical methods of cultivation in systems with organic agriculture and conventional of the system (D.A. Bossio et al., 1998; Clark et al. 1998).

From the perspective of agroecology, organic agriculture is intended to prevent the use of renewable resources at rates exceeding the pace of their recovery, and pollution in excess of the capacity of ecosystems to assimilate. It, thus, is focused not on reception of the maximum effect at present time, and for conservation of conditions for stable maintenance of mankind with the foodstuffs in long-term prospect. The special attention is thus given to quality of food stuffs.

3 Tillage systems and their role in organic agriculture

3.1 Tillage systems and soil fertility

Soil - the main means of farm-production and a basis of agroecosystems. Humanity gets from the soil about 95% of all food products. Concern for the preservation of soil fertility, «health of the soil» should be a priority in agricultural production. One way to impact on soil fertility is soil treatment.

Tillage is one of the key elements of farming systems. Historically, that tillage has designated border of transition of human society from primitive gatherer to a wide cultivation of crops. This allowed significantly improve living standards and further ensured the emergence of craft arts and cities as centres of cultural life.

An important milestone in the history of agriculture has been the emergence of a plow as an instrument of tillage. The credit for inventing the plough belongs to the Romans, who used it to develop the newly conquered lands.

The outstanding Russian scientist, the founder of the theory of farm machines V.P.Gorjachkin wrote: «People understood under the rough, clumsy form of the primitive tool that has helped the person hides will be released from submission to its nature, and has environed this modest tool an aura of high honouring and even sanctity. Romans by means of a plough spent a furrow which served as inviolable border of cities. The Chinese emperor spent itself annually the first furrow» (С.М. Скорняков, 1989).

Undoubtedly, plough tillage has in many respects defined some successes in early agriculture, however with science development the theoretical reinforcement of the received information was required.

Jethro Tull

(1674–1741)

Jethro Tull in England defined necessity reversing soils augmentation of an exposition surface of soil. He believed that the soil maintained on light absorbs the nutrients necessary to plants from atmosphere thanks to what frequent ploughing by a plough can replace entering of a manure or fallow at constant cultivation of wheat

In our country the widespread theory of moldboard ploughing, V.R. Williams (1951), whose provisions for a long time remain immutable. According to this theory, the impact of machines and tools, as well as physiological and biochemical reasons for the end of the growing season of annual crops leads to sputtering of the upper layer of soil, deterioration of its structure. In this regard, V.R. Williams offered to conduct annual ploughing, to make the soil fine structure.

Williams V.R.

(1674–1741)

Soviet soil scientist, agronomist, an academician. Author of over 450 scientific papers. Created the doctrine of common soil-forming process and system restore and improve soil fertility, investigated the formation of soil structure, grounded and developed travopolye farming systems.

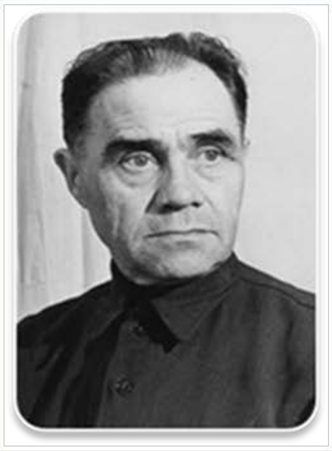
T

he given positions have turned to a paradigm which defined a direction of scientific thought not one ten years.

However, the ideas presented by I.E. Ovsinsky back in 1899 that deep ploughing disturb natural "capillarity" of the soil, turns its homogenous mass quickly drying up in dry weather on all depth of ploughing and sprayed at a rainfall, were left without proper attention.

In 1943 the U.S. published a book by E. Faulkner called « Plowman's Folly», where the author urged to abandon the plough.

Figure 3.1 Dust storm in Texas, 1935.



Maltsev T.S .

1895-1994

Breeder and innovator of Agriculture of the USSR. C 1951 developed Moldboardless system of soil tillage, which included the plow of his own design and the system of agriculture with minimum tillage.

The book was published it in the midst of World War II, when demand soared for agricultural products. In addition, it was still fresh memories of American farmers to ruinous wind erosion, which in the 30 years covered a huge area in the U.S. and Canada. Dust storms in those years caused enormous damage to the economy of these countries, they made unfit for farming large areas of previously fertile land and ruined many farmers.

Refute the position of the need for annual moldboard treatment in Russia allowed the works of scholars such as N.M. Tulaykov (1963); T.S. Maltsev (1988); A.I. Barayev (1988), etc.

From now on has development other directions in system of the primary soil cultivation. One of them assumes a complete elimination of ploughing from system of the primary tillage, and sometimes even transition to zero tillage (Н.К. Шикула, 1989; И.И. Исайкин, М.К. Волков, 2007). Another trend is the differentiated application of different intensities of tillage systems, depending on the dynamics of soil fertility and crop yields (Б.А. Смирнов, С.В. Щукин, Е.В. Чебыкина, В.И. Смирнова, 2005; Г.Н. Черкасов, И.Г. Пыхтин, 2006). In this case, the main task - to save energy resources, under whom, in our view, should be understood not only hydrocarbons but also fertilizers, herbicides, energy of soil fertility, etc.

One of the conditions of transition to organic farming is the preservation and expanded reproduction of soil fertility. A lot of the important role played in this literate structure of tillage system, taking into account climatic and organizational features that are not always taken into account. Very often you can find that under the slogan of "minimizing tillage" imply only a reduction in the number and depth of individual techniques, or even complete their exclusion, as it was with the plowing. It does not take into account any soil and climatic conditions, or biological characteristics of crops. All this could cause a loss of soil fertility and yield of crops.

The system of tillage is the set of methods to tackle specific tasks, and reduce its intensity may not always contribute to the maintenance of soil fertility (Table 3.1).

In the transition to organic farming systems of tillage should be given more attention. Since the ban on the use of pesticides, soil tillage is often the only quick means of regulating the number of weeds. In this regard, the development of tillage in organic farming should be based on the trailers of expediency.

Table 3.1 Decision of problems of soil cultivation in systems different in intensity

Tasks of tillage	Moldboard system	Moldboardless system
Creating the optimum soil bulk density	Plough application allows to quickly adjust the plough on the soil bulk density	Limitation in ploughing use can cause increase soil bulk density (especially on depth more than 10 sm)
Weed control	Competently constructed system of moldboard tillage leads to a reduction in the number of weeds by 85-90%	Provides a good provocation to the germination of annual weeds. But over time, leads to an increase in contamination, which negatively affects the crop.
Incorporation of fertilizer and crop residues into the soil	Ensures even distribution of fertilizer and crop residues in arable layer	Fertilizer and plant residues incorporated into the topsoil, which leads to the redistribution of the root system increases its share in the top layer, which under unfavourable conditions (drought) can reduce yields.

3.2 Features of effective implementation of soil cultivation

The effectiveness of tillage in organic farming is defined by the possibility of solving the problems of processing and conservation of soil fertility. To do this, it is important to take into account the conditions of effective application of tillage systems (Table 3.2.).

Table 3.2 The conditions of effective application of tillage systems

Soil conditions	**Climatic conditions**	**Organizational conditions**
• Soil type • granulometric composition of soil • bulk density • Soil moisture • organic matter content • content of nutrients • Number of weeds	• Rainfall • Temperature	• Set cultivated crops • the need for incorporation of organic fertilizers • Access to and use of appropriate technology

These conditions apply not only to organic farming, and in some sense are universal for all systems with the only difference is that in organic farming, they are more significant.

We now consider them in more detail.

Soil type. Soil type is determined by conditions in which soil is formed. Our country because of its length is characterized by a variety of different types of soils (tundra-gley, sod-podzolic, gray forest, chernozem, chestnut, etc.). Tillage must necessarily take into account the soil type. Without this knowledge it is impossible to manage soil fertility. We have a rather sad experience, when excluding these features are literally implanted system moldboard treatment. The developed VR Vilyams it was mainly focused on a fairly damp Non-chernozem zone. But when she began to take root throughout the USSR, from the western borders to the east, from the Arkhangelsk region to Armenia, it led to disastrous consequences. Now we can become hostages of other extreme measure when under the slogan of power saving up are popularised soil-protective processings zero technologies (No-Till).

Soil organic matter. Opportunity to minimize soil tillage is largely determined by the level of its fertility. Organic is an integral index of soil fertility. The more organic matter a soil contains, the better the physical properties of soil. The optimum soil bulk density is close to equilibrium, which gives grounds to reduce the mechanical impact on the soil to optimize it. In this case, intensification of treatment leads to excessive aeration of the soil and organic matter loss (А.Ф. Витер; Сулейменова М.К., 1991; Я. Эпперляйн, Ф. Эльмер, 2007).

Granulometric composition of the soil. Grain-size composition is an important characteristic of the soil, which determines its structural state erosion control and stability. Of grain size depends selection tools and the depth of tillage, seeding depth, conditions for effective use of organic fertilizers, etc. For example, a green manure to make better use on sandy and loamy soils.

Soil bulk density. Soil bulk density largely determines the possibility of minimum tillage. Knowing the magnitude of optimum density of the soil for some crops and the actual density of the field at any given time, we can confidently speak about the need to use some tillage system. It is considered that the difference between equilibrium and optimum soil bulk density is the scientific basis of loosening or soil compaction. The use of subsurface, surface and zero tillage is largely due to a minor difference between the equilibrium and optimum soil bulk density.

Soil moisture. Determines the most optimal time for tillage.

There is a range of moisture contents, within which the mixing of soil during tillage leads to the formation of good soil structure. In the interval marked by the free energy surface of the air-water is still determined by the surface area of film, which is stirring and loosening the soil Tillage tends to take along with soil particles form with a minimal surface, ie spherical form, and therefore falls into the soil aggregates are more or less rounded (А.Д. Воронин, 1986).

That is, with increasing soil moisture, water shell around the particles reach a state in which soil particles are held with sufficient force, and coming into contact with each other, firmly hold the particles close to each other; soil thus has greater strength In the area of maximum strength form an optimal physical conditions for soil tillage, in particular its crumbling, and formations of agronomically valuable aggregates (Д.Д. Хайдапова, А.В. Аксёнов, 2001).

The content of nutrients in the soil. The content of the soil nutrients available to plants in the form, ensuring normal growth and development may be one reason for minimizing tillage.

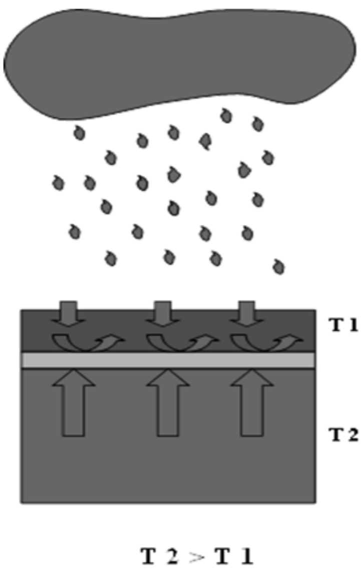
The fact that tillage increases the mobility of organic matter, causing its mineralization. In the soil become available nutritious, used the plant to yield formation. Decrease in mechanical influence on soil, at deficiency of nutrients in soil can become the cause of decrease in productivity of cultivated plants. Reduced mechanical stress on the soil, with a deficit of nutrition elements in soil can cause yield reduction of crops. Of particular importance is acquired during the transition to organic form of farming, as opposed to traditional farming to resolve this issue through the fertilizer does not happen.

Infestation by seeds and vegetative organs of reproduction of weeds. Since the decrease in the number and depth of tillage, usually accompanied by an increase in the number of weeds, in this case the infestation can act as one of the criteria for an acceptable level to minimize soil tillage.

Amount of precipitation and their intensity. The use and intensity of soil tillage must be differentiated depending on the number and intensity of precipitation. For example, in areas with low rainfall tillage should be done to conserve soil moisture. The soil should be covered as a mulch to reduce evaporation of soil surface. In addition, mulching treatment prepyadstvuet development of erosion processes.

Soil temperature. The temperature of soil and its dynamics defines character and speed of course of chemical and physical processes, biological activity of soil. Thus, the use of mulch and zero tillage significantly reduces the coefficient of thermal conductivity, which reduces the temperature between the topsoil and subsurface horizons. It is very important because the effect on the migration of soil moisture.

On the other hand in regions with colder climates soil cover crop residues under No-Till can cause a slow spring warm the soil, which slows down the germination of seeds of cultivated plants, and may also be the cause of lack of nitrogen in spring (U. Zihlmann, at al 2001).



In soil, the water is concentrated within the capillary channels and moves under the influence of the temperature difference between the different parts of the canal, and, specifically, from the point with higher temperature to a point with a lower temperature. In the autumn season at air chilling effect the soil surface cools down also. At the same time on some depth there is the layer, which temperature above, than temperature of overlying horizon. Movement of moisture under the influence of temperature drop is directed upwards to the soil surface. This raises the water seal that prevents the free flowing of excess moisture, precipitating in the form of autumn precipitation in the lower layers of soil. Arises autumn slush. The soil in the wet for a long condition that affects the physical properties of soil, there is a danger of erosion. A similar pattern can be observed in spring .

Set cultivated crops. Crops are characterised by certain biological features and differently react to depth and intensity of soil cultivation.

They can be divided into 3 groups:

1. Crops well responding on soil tillage - alfalfa, clover, vetch, forage legumes, perennial fruit and berry crops (before planting).
2. Crops average responding perfectly to soil tillage - maize, winter wheat, root vegetables, potatoes, timothy.
3. Crops poorly responding perfectly to soil tillage - winter rye, spring wheat, oats, flax.

So, according to NV Kolomiets (1990) reaction to the replacement of moldboard tillage to moldboardless tillage for winter wheat placed on the seam of clover, was negative, whereas after silage corn adverse effects were observed.

The need for incorporation of organic fertilizers. Application moldboard tillage provides the best incorporation of manure and compost into the soil. It is beneficial to the growth and razvtii crops and creates favorable conditions for the transformation of organic matter in humic compounds.

Access to and use of appropriate technology. Go to a particular technology for cultivation requires a range of relevant technology, which provides a clear performance goals. The transition to organic farming requires a balanced and rational approach to resolving this issue. Particular attention should be paid to the availability of quality tillage equipment for more effective control of weeds.

3.3 Minimizing tillage: Advantages and disadvantages

Tillage systems can be grouped in two main areas: classical system based on the moldboard treatment of VR Williams and resource-saving systems which are based on the minimization of tillage (surface, combined, mulching, zero).

In recent years, minimizing tillage is regarded as one of the most important conditions of ecological agriculture. According to recent data, there are about 400 million hectares of land used for minimization of tillage and 100 million hectares of zero tillage and their volume of annual increase. In Russia, however, resource-saving technologies, there are only 1% of agricultural lands. Against this backdrop, the pace of soil degradation Russian Federation since the early 90-ies is one of the first places in the world (Л.В. Орлова, 2007).

Indeed, the introduction of minimum tillage in many ways to stop the degradation processes, which were caused by the widespread and often ill-considered implementation of the system moldboard treatment. Even today in Russia is characterized by the highest plowed farmland (in average 66%), amounting in many areas up to 80% or more. Their permanent degradation increased sharply due to the destruction of the 90-ies already imperfect system of agriculture, which is due to the lack of machinery, fertilizers, crop protection, non-compliance and imperfect technologies for growing crops without regard to their biological characteristics.

The degradation of centrally planned management of agriculture and the country's transition to a market economy required tasks and economic nature, especially that for many farms it was the subject of survival. High energy consumption is the annual moldboard tillage in the absence of the necessary quantity of technique for its timely carrying out transforms the classic ploughing into the traditional plowing. That is plowing is often done late, when the weeds have already outgrown the optimal phase of suppression or does is transferred to the spring-summer period. This leads to late planting dates, soil moisture loss, deterioration of plant growth and development, reduction of yield. Often spend plowing soon after harvest crops without the prior disking. There is no provocation for germination of seeds and vegetative reproductive organs of weeds, which increases the infestation of crops and reduces the effectiveness of this technique.

Therefore interest to minimisation to soil cultivation is clear. However, in Russia in recent years there has been a spontaneous "minimization", often not related to new technologies. This simplistic attitude to the systems of tillage due to lack of means of production or illiterate approach to the problem. При всем значении и перспективах минимизации обработки почвы процесс этот достаточно сложный, поскольку связан с преодолением ее недостатков (В.И. Крюшин, 2006).

The present campaign, in contrast to the previous party-state, is a market-bureaucratic in nature. In addition, it is often the product of a commercial nature manifested in the form of aggressive and assertive advertising that promotes a company maker machinery or pesticides. At the same time made sufficiently incoherent and fragmentary references to scientific sources, a detailed study of which does not hold water.

In the mentioned improvised recommendations of advantage minimum and even zero soil cultivations it is often advertised without serious instructions on lacks. In this case, along with the promotion of international experience made lightweight reference to the I.E. Ovsinsky, N.M. Tulaykov and T.S. Maltsev. Meanwhile the history of development of idea of minimization more than is instructive. The drama of first two trailblazers, who have been not accepted by contemporaries, is bound to difficulties and subtleties of overcoming of a weed infestation of crops at shallow soil cultivation. Considering their experience, T.S. Maltsev has developed system moldboardless tillage where additional methods of controlling weeds were used. It first of all a clean fallow and optimum late times of the sowing, allowing to reduce weediness by means of presowing cultivations. In the further T.S.Maltsev has been forced to add the system with application of herbicides without which not always it was possible to cope with weeds, even at the high standard of farming (В.И. Крюшин, 2006). A.I. Baraev also has been forced to solve a weediness problem at transition on moldboardless tillage at the expense of augmentation of a lobe of clean fallows (Е.И. Шиятый, 2007).

***No-till farming (also called zero tillage or direct planting or pasture cropping)** is a way of growing crops from year to year without disturbing the soil through tillage. No-till is an agricultural technique which increases the amount of water and organic matter (nutrients) in the soil and decreases erosion. It increases the amount and variety of life in and on the soil but may require herbicide usage.*

Table 3.3 The main advantages and disadvantages of minimisation of soil cultivation

Advantages of minimizing tillage	Disadvantages of minimizing tillage
• Hinders the process of mineralization of organic matter and nitrate migration beyond the root zone. • Minimizing tillage - the basis of ecological agriculture. • Improving soil structure;. • Increase biodiversity, which determines sustainability of agroecosystems. • Reduction of CO_2 emissions into the atmosphere. • Reduce costs of fuel and lubricants, machinery depreciation and cost of labor. • No-till (in some areas) prepyadstvuet development of erosion.	• Increase in the number of weeds. • Soil cultivation minimisation (moldboardless tillage) enhances deficiency of nitrogen. • Increased soil bulk density and soil penetration resistance of the underlying layers. • Differentiation occurs plow layer on the elements of soil fertility (soil structure, humus, nutrients, etc.) that under certain conditions can cause yield reduction of crops. • The surface runoff increases in erosional landscapes.

The main drawback moldboardless tillage is increase of weediness of crops - increases with increasing moisture to the north of the forest-steppe and taiga-forest zone. In the same direction deficiency of nitrogen strengthens while minimizing tillage, and increased soil compaction and erosion in the landscapes of increasing surface runoff. Accordingly, minimizing tillage in this direction are limited. If in the steppe zone could potentially dominate zero tillage, the forest-steppe optimum tillage systems consist of various combinations of minimum tillage with ploughing, as in the taiga-forest zone in combination increases the proportion of ploughing.

Tillage system can be represented as follows (Figure 3.2):

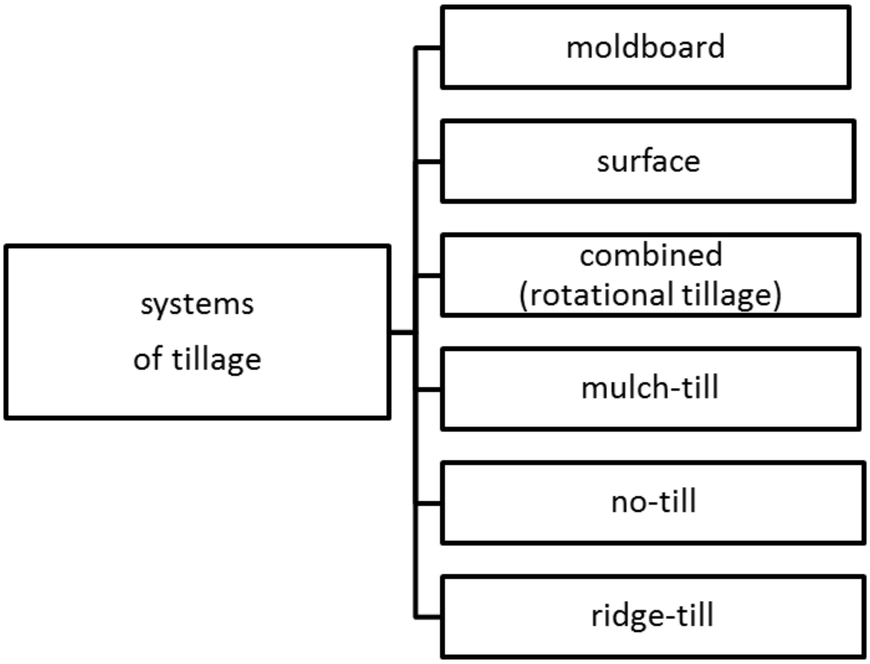


Figure 3.2 Classification systems of tillage

Possibilities of minimisation of soil cultivation increase in process of security industrial resources and professional knowledge. In view of conditions of effective application of soil cultivation it is necessary to consider competently existing features which should reflect the landscape approach.

3.4 The concept of energy-saving soil cultivation - ecological and economic aspects

Energy-saving technologies are well positioned in our lives. The purpose of energy conservation in general is to increase energy efficiency in all sectors for the country's economic development and improve the ecological situation. Was no exception, and agriculture. Recently, however, in agriculture under the energy-saving technologies is understood only reducing the resources of fuels and lubricants by reducing the number, depth and intensity of tillage. This simplified approach leads to misinterpretation of concepts, and can cause not only loss of productivity of the fields, but also lead to serious environmental consequences.

Table 3.4 Environmental and economic aspects that characterize the energy-saving tillage

Environmental aspects	• Save and maintenance of soil fertility • Reducing soil erosion • Maintaining biological diversity
Economic aspet	• Reducing fuel consumption • Reduce labor costs • Reducing the cost of equipment depreciation • Improving the organization of labor

Energy-saving in agriculture *are a reduction of expenses of cumulative energy by a unit of production without deterioration of its quality and without productivity decrease at ecological balance of systems and soil conservation from degradation.*

Therefore energy-saving tillage should be considered by all means as the element of agrotechnology which is in close interaction with other elements (a crop rotation, fallow, previous crop, fertilising, etc.) and agroecological conditions which to some extent define a choice of a mean of tillage, depths, frequencies, possibilities of combination of operations. Being in the system interaction, the main elements of agricultural technologies have common features. For example, crop rotation and soil cultivation system performing the regulatory function of soil water regime, optimization of their structural state regulatory phytosanitary condition of agricultural lands, protect soil from wind and water erosion, the regulation of organic matter and nutrients. In some cases a function can be enhanced by an appropriate choice of crop rotation, or adjustments in the other - the system of tillage. At the same time play a critical role of fertilizers and crop protection from pests. In addition to their direct effects on individual performance factors and agro-ecological conditions of land, they have an indirect impact on all of these factors through the selection of crop rotation and tillage system.

Maneuvering technology elements depending on the nature and working conditions, taking into account systemic linkages determines the stability of its agriculture ecological and economic efficiency (В.И. Кирюшин, 2006).

3.5 Features of tillage in organic agriculture

Soil tillage is often perceived to exert negative effects on organic farming systems. This perception likely stems from the consideration that tillage can deteriorate soil structure, disrupt ecological niches for soil biota (e.g. earthworms and vesicular-arbuscular mycorrhizae) that have positive ecological functions in agroecosystems, enhance soil organic matter mineralization and impair soil organic matter build up, increase risks of nutrient losses to the environment and of soil erosion and ultimately contribute to soil fertility loss and soil quality degradation. This applies especially to the most intensive system of moldboard tillage (Table 3.5.).

Reduction in the intensity of tillage is one of the conditions in the transition to organic farming. So, according to rules National Organic Program the USA, the certificated organic farms should document carrying out of methods on soil tillage.

At the same time it is necessary to tell that the wide circulation of the minimum soil cultivation became possible only at the expense of augmentation of application of pesticides and fertilizers. In organic farming it is inadmissible. Moreover, the problems of soil cultivation directed on struggle against weeds, pests and diseases here get the special significance, being one of determinant factors of successful conducting organic agriculture.

Thus, soil cultivation methods can have positive and negative sides in organic farming depending on developing conditions. Thus it is necessary to give special value to a climatic zone.

Table 3.5 Short- and long-term effects of conventional tillage

Transient Benefits	Long-term Consequences
Reduces soil compaction	Increases soil compaction upon rapid soil consolidation
Increases soil porosity	Reduces soil macroporosity and biological activity
Eliminates crusting and surface sealing	Induces severe crusting and seal formation
Accelerates release of essential nutrients upon decomposition of organic matter and increases nutrient uptake	Decreases the soil organic matter content and nutrient cycling and availability
Improves fluxes of water, air, and heat	Decreases hydraulic conductivity and air permeability
Reduces runoff because of increased surface roughness	Decreases infiltration rate and increases runoff
Promotes rapid emergence and plant growth by loosening the soil	Decreases crop production due to reduced water storage and increased evaporation

Source: H. Blanco, R.Lal, 2008

V.I. Kirjushin (2006) differentiated systems of soil cultivation depending on zonal conditions (with reference to the basic zonal types of soils) and levels of an intensification of agriculture.

Table 3.6 The system of soil cultivation depending on zonal conditions

Soils	Intensification levels		
	1st	2st	3st
Sod-podzolic	P	Sod-podzolic	P
Gray forest soils	P	Gray forest soils	P
Podzolic and leached chernozem	P	Podzolic and leached chernozem	P
Typical chernozem	P	Typical chernozem	P
Chernozems ordinary and southern	P, C	Chernozems ordinary and southern	P, C
Chernozem saline	C	Chernozem saline	C
Dark chestnut and chestnut soils	C	Dark chestnut and chestnut soils	C
Dark-chestnut alkaline soils	C	Dark-chestnut alkaline soils	C
Light-brown soils	C	Light-brown soils	C

Symbols: P – ploughing system; C – combined system of tillage; M – mulching; Mм – mulching minimum; N – no-till.

Source: В.И. Кирюшин, 2006

From resulted above the table follows that introduction of the minimum technologies of soil cultivation is possible only under certain conditions. This applies particularly to the sod-podzolic soils. It should be the application of fertilizers, integrated plant protection system, the availability of appropriate equipment and the necessary knowledge and skills.

Organic farming usually referred to the extensive forms as do not use synthetic pesticides and fertilizers. Therefore organic farming often use conventional (moldboard) tillage for more effective weed control, and especially with the most malicious perennial species (U. Koepke, 2003; J. Peigné et al. 2007). These and other research have led some scientists to believe that conventional farms, where zero technologies (No-Till) are applied provide more favorable conditions to maintain and improve soil fertility compared with organic farms, which is associated with weed control due to more intensive tillage (A. Trewavas, 2004). Although studies conducted in Maryland (J.R. Teasdale et al., 2007) and Montana (P.R. Miller et al., 2008) show that the usual No-Till cannot be higher organic farming to improve soil quality. Nevertheless, many organic farms wish both decrease in intensity of soil cultivation, and absence of problems with weeds.

Thereupon there is a question, whether there is a possibility of soil cultivation which would combine in itself both ecological advantages, and efficacy of struggle against weeds without use of synthetic pesticides and fertilizing. And, first of all it concerns sod-podzolic and grey forest soils (tab. 3.6.).

The researches executed on sod-podzolic soil of a miscellaneous granulometric composition have shown efficacy of the combined system of surface-moldboard tillage without application of fertilizers and herbicides (Б.А, Смирнов, 2002, Б.А Смирнов, С.В. Щукин и др., 2005). This system of tillage does not lead to an increase in infestation of crops and improves the biological, physical and chemical properties of soil. The differentiated approach to soil cultivation depending on dynamics of the soil fertility, cultivated crops and a fytosanitory state of crops allows optimizing a combination moldboard and surface tillage in the rotation.

Construction principles of tillage in organic farming:

- Conservation of soil fertility by minimum soi tillage. The permissible level of minimum soil tillage for different soil-climatic zones of the country.
- Control of weeds, pests and diseases.
- Incorporation of organic fertilizers.
- Coordination of soil tillage system with the biological characteristics of crops.

In addition, special attention should be paid to competent crop rotation and the need to use green manure crops.

4 Fertilizers in organic farming

4.1 Fertilization and soil fertility

Nutrition - the foundation of life of any living organism, including plants. Outside food cannot understand the processes of growth and development.

In terms of crop production essential tool for improving food crops is, above all, use of fertilizers. In addition, remains an urgent problem of conservation and the expanded reproduction of soil fertility, are in prolonged use, and on this basis to obtain high and sustainable yields of crops (V.T. Rymar, G.P. Pokudin, S.V. Mukhina et al, 2003; V.A. Korolev, L.D. Stahurdlova, 2004; G.B. Kirillova, A.S. Allayarov, 2007; D. E. Vanin, Y. D. Vanin, A.A. Myasnyankin, I.V. Butko, 2008). Solution to this problem is carried out scientifically methods of farming, one of which is also the use of fertilizers (V.G. Nebytov, V.V. Kolomeychenko, 2005; I.P. Makarov, 2007).

According to many researchers (S.H. Dzanagov, T.K. Lazarov, A.E. Basiev, 2003; V.G. Nebytov, V.V. Kolomeychenko, 2005) correctly selected the system of fertilizer provides non-deficit balance of humus, as well also expanded its reproduction in the soil, improving the physical, chemical and biological properties of soil, creating optimum conditions for plant mineral nutrition, improving the sustainability of agriculture in adverse weather conditions.

In modern agriculture, a specific role for mineral fertilizers.

Numerous studies indicate that the increase in productivity and quality of crops cultivated with mineral fertilizers (V.I. Volynkin, O.V. Volynkina, V.A. Telegin, 2007; N.S. Almetov, A.S. Kozyrev, 2008; R.S. Kiraev, F.Y. Bagautdinov, N.M. Nurmuhametov, S.I. Fedorov, R.G. Yagafarov, 2008; V.S. Kursakova, D.V. Drachev, 2008; V.V. Lapa, N.N. Ivakhnenko, 2008; G.M .Mamedov, 2008). Application of fertilizer improves the nutrition, promotes greater rise of aboveground mass and content in her NPK, which has a positive effect on crop plants (G.V. Ovsyannikova, 2006; I.A. Vinogradova, 2008).V.T. Rymar together with co-authors (2003), M.M. Khaibullina et al (2007) found that an increasing doses of mineral fertilizers are increase the activity of catalase.

However, the use of mineral fertilizers can be characterized a number of negative phenomena. According to M.F. Ovchinnikova, N.F. Gomonova, V.G. Mineev (2003); A.G. Prudnikova (2004); V.N. Dyshko, L.P. Kostin, I.V. Pankratenkova et al (2005); N.M. Domanov, K.B. Ibadullaeva, P.I. Solntseva, S. V. Trapeznikov (2008) the application of some fertilizers are acidifying the soil solution increases the hydrolytic acidity, increased mineralization of organic matter and humus content decreases. This circumstance leads to the deterioration of agrophisic soil properties and reduces their resistance to compaction.

Moreover, the negative effect of fertilizer on the degradation of soil structure is enhanced with increasing doses and duration of introduction (A.N. Sapozhnikov, M.F. Kornilov, 1977). The authors note that systemic application of mineral fertilizers and its acidifying action is the destruc-

***Chemical fertilizers** contain nutrients in the form of various mineral salts. Depending on what nutrients are contained in them, mineral fertilizers are divided into simple and complex. Simple (unilateral) fertilizers contain one of a nutrient. These include phosphorus, nitrogen, potassium and micronutrient fertilizers. Complex, or multilateral, fertilizers contain a combination of two or more major nutrients.*

tion of water-stable aggregates as a result of dissolution of calcium humates, employees cement for elementary soil particles.

Studies conducted E.I. Shkonde and Z.K. Blagoveschenskaya (1982) suggest that the destruction of soil structure under the influence of mineral fertilizers can be caused by the action on the SAC of monovalent cations, especially Na +, contributing to dispersion and dispersion of humus colloids.

An introducing high doses of fertilizers are marked changes in the community of cellulolytic microorganisms - reducing the number and percentage of cellulolytic bacteria and an increase in actinomycetes. This fact should be considered as a manifestation of the negative effects of high doses of fertilizers on soil biological properties as well as actinomycetes are active producers of phytotoxic substances, and thus may contribute to soil toxicity (V.G. Mineev, E. J. Rempe, 1990; G. M. Breskina et al, 2009).

The negative effect of fertilizer can be observed during prolonged systematic use of high doses and increases with their concentration in the soil. This changes the structure of the microbial complex, increasing the number of pathogenic forms of microorganisms, there is accumulation of phytotoxin, whose action is manifested in the inhibition of plant and invertebrate animals, ie soil microbial toxicosis (T.G. Mirchink, V.S. Guzev, 1984; A.V. Kurakov, A.I. Popov, 1995; V.A. Korolev, L.D. Stahurlova, 2004; I.A. Tikhonovich, Y.V. Kruglov, 2006).

N.A. Krasilnikov (1964), I.D. Svistova et al (2003), E.F. Meretskov and M.M. Demchenko (2008) fungal species identified as indicators of microbial toxicity: Aspergillus clavatus, Fusarium solani, Talaromyces flavus, Penicillium rubrum, P. funiculosum.

Long-term introduction of nitrogen, potassium and nitrogen-potassium fertilizer occurred a marked increase in the percentage of toxic forms of fungi (T.G. Mirchink, V.S. Guzev, 1984; A.V. Kurakov, Y. E. Kozlova, 2002; L.A. Nechaev, N.P. Torubarov, 2003).

Nitrogen fertilization on the background of phosphorus-potassium led to a significant decrease in number and living biomass of earthworms in the 1,19-2,06 times (N.I. Kuleshov, O.V. Igoshina, 2006).

A.I. Lahidov (2005) noted that the effect of fertilizers on insect fauna of field crops is expressed in a direct their action on insects and indirect, which may be expressed as a death benefit of the insect fauna, as well as in promoting survival and fecundity of insects.

In addition, excess nitrogen fertilizer reduces the resistance of plants to disease, impairs the taste and technical quality, leads to the accumulation of nitrates and nitrites in plants.

Summarizes the positive and negative aspects of the application are summarized in Table 4.1.

However, it should be noted that this division is rather approximately, since adverse effects usually occur when using high rates of mineral fertilizers without taking in consideration the soil and climatic conditions, biological features of plants and the possibility of additional agricultural practices. It is also important to note that a careful combined use of mineral fertilizers with organic ones greatly reduces the negative impact of fertilizers and increases soil fertility.

Table 4.1 Positive and negative aspects of mineral fertilizers application

Positive aspects	Negative aspects
• Improves the nutrition • Have a high concentration of nutrients, which reduces the cost of implementation • Increase the yield of crops • When combined with organic fertilizers contribute of soil fertility	• Are responsible for acidification of the soil solution • Enhance mobility organic matter in the soil, leading to a decrease in its content • degrade the soil structure • help to increase the number of pathogenic forms of microorganisms and the accumulation of phytotoxin • can help reduce the number and biomass of earthworms • excess nitrogen fertilizer reduces resistance plants to disease • impairs the taste and technical quality, leads to the accumulation of nitrates and nitrites in plants • Increases the mass of weeds and loss of nutrients • When used incorrectly can contribute to environmental pollution

In organic farming, there are limitations in the use of mineral fertilizers. Instead of making the nutrients directly into digestible form provided for the completion of the nutrients is mainly due to three sources:

- different organic fertilizers;
- soluble minerals;
- nitrogen-fixing plants.

As additional sources of mineral nutrition allowed the use of basalt meal, seaweed meal (in some countries produce more flour recipes), meat, meat and bone, bone and horn meal, flour, bristle, wood ash, phosphate rock, basic slag, dolomite, limestone powder, kalimagneziya.

The transition from traditional to organic farming requires a more thorough and meaningful understanding of the tasks in terms of plant nutrition, because insufficient attention to these issues could lead not only to significantly reduce crop yields tilled crops, but also cause degradation of soil fertility. This requires knowledge of plant nutrition, having regard to the principles of organic agriculture to ensure the exchange of substances between plants and the environment.

4.2 Management of plant nutrition

The plant builds the body of certain chemical elements in the environment. It consists of dry matter and a significant amount of water. In most of the vegetative organs of crop water content is 70-95%, and seeds - from 5 to 15%. The composition of dry matter of plants is 90-95% of organic compounds and 5-10% mineral salts.

Analysis of the elemental composition of plants shows that they contain on the average C - 45%, O - 42%, H - 6,5%, N - 1,5% dry weight. Plants get their carbon from CO_2 air, oxygen and hydrogen from water. Oxygen is also involved in the exchange process of respiration. Nitrogen and the elements that make up the ashes, comes into the plant through the root system from the soil mainly in the form of mineral compounds. Green plants - autotrophs because they have a source of carbon is CO_2, and to build organic substances they use other elements in the form of mineral compounds.

Table 4.2 Necessary nutrients for plants

Nutrients	**Available form**	**Source**
Are needed in large quantities		
Carbon	CO_2	Atmosphere
Oxygen	O_2, H_2O	Atmosphere and soil pores
Hydrogen	H_2O	Water in the soil pores
Nitrogen	NO_3^-,NH_4^+	Soil
Phosphorus	$H_2PO_4^-$, HPO_4^{-2}	Soil
Potassium	K^+	Soil
Calcium	Ca^{+2}	Soil
Magnesium	Mg^{+2}	Soil
Sulphur	SO_4^{-2}	Soil
Are needed in smaller quantities		
Iron	Fe^{+2}, Fe^{+3}	Soil
Manganese	Mn^{+2}	Soil
Copper	Cu^+, Cu^{+2}	Soil
Zinc	Zn^{+2}	Soil
Boron	H_3BO_3	Soil
Molybdenum	MoO_4^{-2}	Soil
Chlorine	Cl^-	Soil
Cobalt	Co^{+2}	Soil
Nickel	Ni^{+2}	Soil

Notes:

1. Sodium (Na) is considered one of the most important elements for some plants, especially in saline soils.
2. Selenium (Se) is not considered an essential element for plants, but it is extremely important for animals.
3. Silicon (Si) is considered essential for normal growth and development of rice.

Source: F.Magdoff, et al, 2010

In the plant body all processes are closely interrelated. Exclusion from the nutrient solution of any desired element is rapidly changing in many, if not all, of the processes of metabolism. In this connection, highlight the primary effect is extremely difficult. The foregoing applies primarily to those nutrients which are not members of certain organic substances, and are more regulatory, or some other role. In general we can say that nutrients have the following meanings: 1) are part of biologically important organic compounds, and 2) are involved in the creation of a specific ion concentration, stabilizing macromolecules, and colloidal particles (electro-chemical role), and 3) are involved in catalytic reactions, entering in or activating certain enzymes. In many cases the same element can play different roles. Some elements of performing all three functions.

Features of the content and distribution in plant nutrient determine differences in the requirements of individual crops to the nutrients.

Biological characteristics of plants and its growth conditions determine the removal of nutrient with the harvest of various crops. Average consumption of nitrogen, phosphorus and potassium on the formation of a unit of commodity output of major crops are given in Table 4.3.

Table 4.3 Approximate cost of basic nutrients (kg) to establish the identity of commodity products

Products	**Nutrient (in the form of)**		
	N	**P_2O_5**	**K_2O**
Per 1 ton of main production and a corresponding amount of secondary one			
Grain of wheat	30-35	10-12	20-25
Grain of corn	30-35	8-12	25-35
Grain of cereal crops (buckwheat, millet)	30-35	10-15	30-40
Grain of legumes (pea, vetch)	60-70	12-15	20-25
Flax fiber	55-70	25-30	65-80
Seeds of sunflower	55-70	25-30	170-210
Per 10 ton of main production and a corresponding amount of secondary one			
Tubers of potato	50-60	15-20	70-90
Roots of sugar beet	50-60	15-20	60-100
Fodder roots	45-60	10-20	60-120
Head of cabbage	30-40	12-17	40-60
Tomato	30-35	10-15	35-50
Per 1 ton of hay			
Hay of vetch-oats mixture	20-25	5-7	15-25
Hay of clover-timothy mixture	15-20	5-8	15-25
Hay of alfalfa	25-30	4-7	15-20

The total demand for agricultural crops in the mineral elements is characterized by the size of biological removal - the number of these elements in the whole plant biomass formed, ie, in the aboveground organs and roots. Consequently, the biological removal include the nutrient content in both alienated from the field of primary and secondary production (economic removal) as well as in root and crop residues, leaf litter fall (residual removal).

Ratio of nutrients, which spent on the creation of agricultural products, can vary significantly depending on the culture and structure of the crop. For example, an increase in the biological yield of grain straw share in the creation of 1 ton of production (grain) consumed significantly more food nutrients.

Efficient nutrient management in the form of fertilizers is an important condition for improving the productivity of plants and preservation of soil fertility. It acquires special significance in organic farming. For competent construction of fertilizers in organic agriculture must be considered:

- supply nutrients to plants at different periods of growth
- remove nutrient by yields of crops
- the use of nutrients from the soil by crops
- crop rotation
- effect of crop and root crop residues on the nutrition properties of the soil
- presence and using of organic fertilizers and green manure
- method of applying of organic fertilizers
- uptake by plants of nutrients from organic fertilizers
- degree of contamination by weeds
- soil and climatic conditions.

4.3 Organic fertilizers as the basis of the ecologically sustainable agriculture

Organic matter plays a decisive role in shaping the potential of soil fertility and stability (S.H. Dzanagov, T. K. Lazarov, A.E. Basiev, 2003, V. Voronov, S. Shishov, 2008). This should be considered in constructing the system of fertilization, which is especially important for sod-podzolic soils (I.A. Ivanov, A.I. Ivanov, V.F. Ivanova, 2002) and the transition to organic forms of farming (F. Magdoff et al, 2010).

Removing from the soil by yields the most of organic matter and without compensating its organic fertilizers, we are creating the conditions for slowing down or even complete cessation of the process of soil formation (I.B. Sorokin, E.V. Titova, L.V. Kasimov, 2008). Therefore, the use of organic fertilizers is essential for the maintenance of soil fertility and to obtain high and sustainable yields (A.F. Safonov, A.A. Alferov, 2002; M.H. Shirinian, V.K. Bugaevskiy, V.M. Kildyushkin, H.G. Romanov, 2008).

All fertilizers can be classified by origin, physical state, mode of action, methods of application (Figure 4.1.)

The application of organic fertilizers is one of the most effective methods of replenishment of organic matter and nutrients in the soil (B.A. Smirnov, S.V. Shchukin, 2005). As for organic farming, the use of organic fertilizers is a prerequisite for the successful this system (K.W.T. Goulding et al., 2001, Watson et al. 2002a, Stockdale and Cookson, 2003).

Organic fertilizers promote consolidation and growth of the total water-stable aggregates, as well as their redistribution among the groups of fractions. Application of organic fertilizers not only reduces the density of the soil, but longer periods of time keeps it in the loose state (N.A. Chuyan, N.P. Masyutenko, R. F. Eremin, 2008).

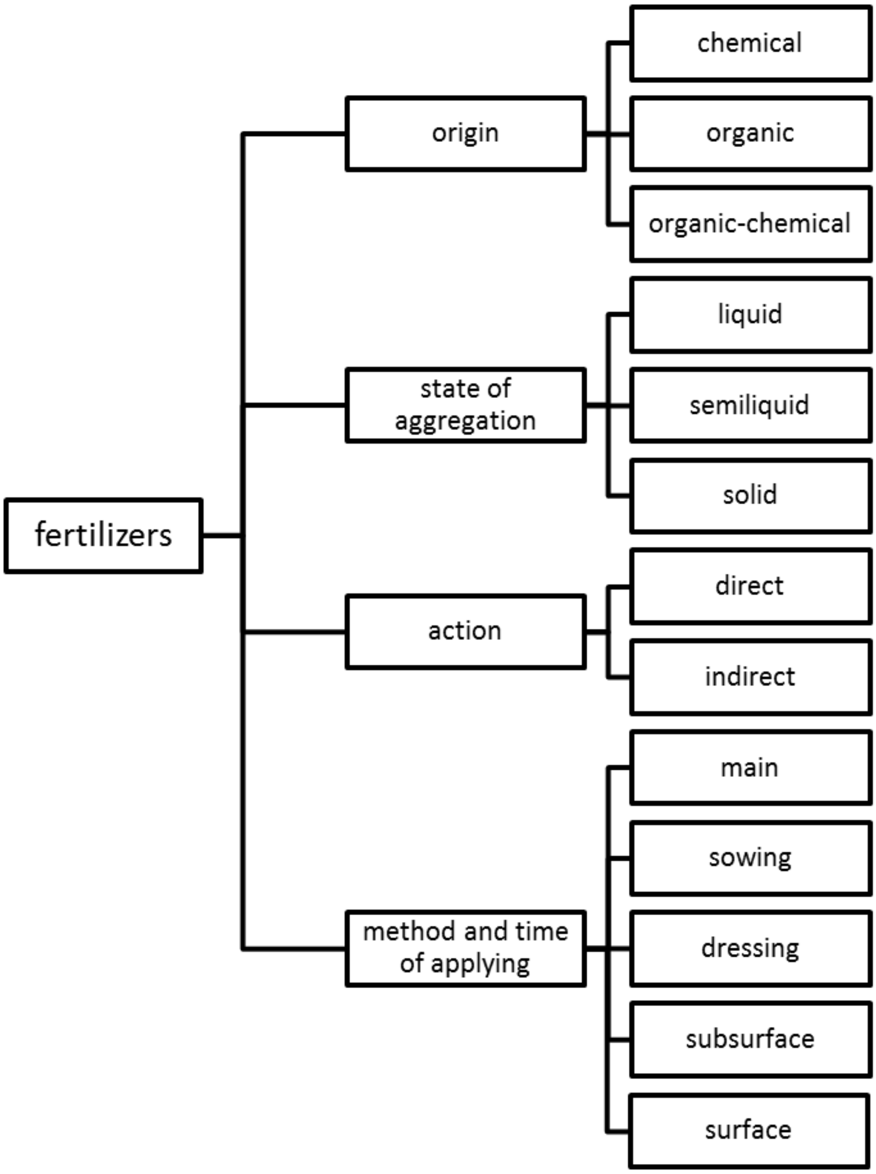


Figure 4.1 Classification of fertilizers

The use of organic fertilizers contributes to the significant increase in stocks of soil moisture (E.P. Bojko, S.I. Barshadskaya, L.N. Vyshegorodtseva, 2005) and its biological activity (R.V. Naumetova, 2007). Incorporation of fresh plant mass in the soil, rich in proteins and carbohydrates, increases the activity of catalase (V.G. Loshakov, 2007).

Brief classification of organic fertilizers is shown in Figure 4.2.

Manure. This is the most valuable organic fertilizer. In various animal manure contains on average (%): water 75, 21 organic matter, total nitrogen 0.5, digestible phosphorus 0.25, potassium oxide 0.6. The quality of the manure depends on the type of animal, its feed, bedding and storage method.

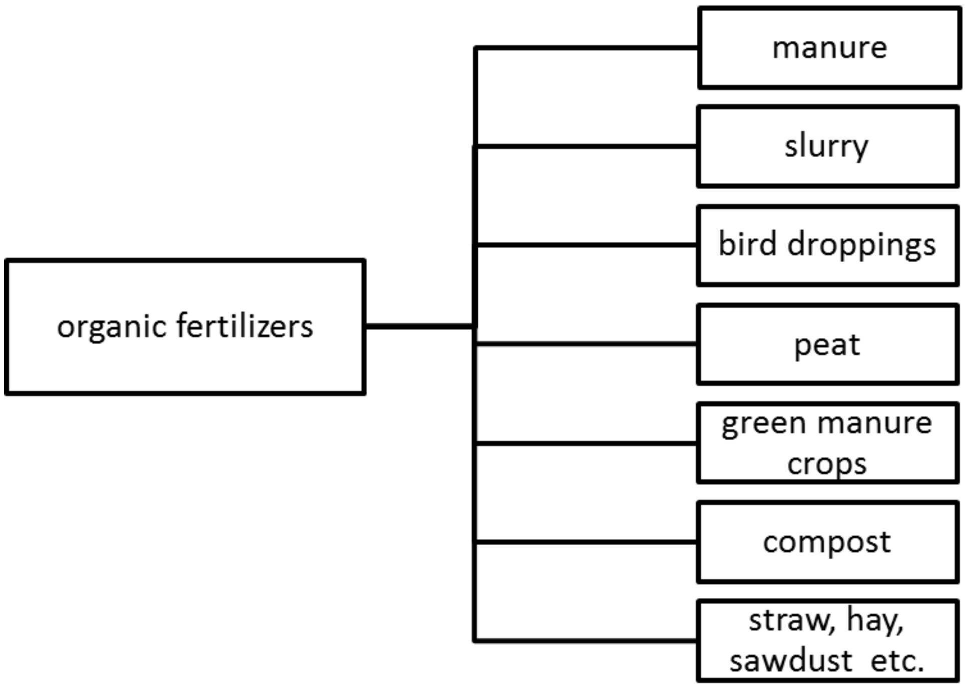


Figure 4.2 Classification of organic fertilizers

To balance a deficit-free organic matter per year per 1 hectare to make 10 tons.

In member countries of the European Union (including Finland) in accordance with the Nitrates Directive stipulates that the agricultural fields can contribute no more than 170 kg / ha of nitrogen in manure per year. This amount is usually obtained with 40-50 tons of manure.

Table 4.4 The composition of fresh manure on straw (%)

Animals	**Water**	**Organic matter**	**Nitrogen, N**	**Phosphorus, P_2O_5**	**Potassium, K_2O**	**Calcium, CaO**
Cattle	77,3	20,3	0,59	0,23	0,50	0,40
Horse	71,3	25,4	0,77	0,28	0,63	0,21
Sheep, goat	64,6	31,8	0,83	0,23	0,67	0,33
Pig	72,4	25,0	0,65	0,19	0,60	0,18

Peat. The peat contains little available for the plants of nutrients, but it increases the humus content and improves soil structure. The dark color helps absorb the heat of peat and rapid heating of the soil.

According to different estimates of the world from 250 to 500 billion tons of peat (in terms of 40% humidity), it covers about 3% of the land. In Russia, leading to peat, the employment share of the lands up to 31.8% in Tomsk Oblast (Vasyuganskiy swamps) and 12,5% in the Vologda. World leader in the production of peat is Finland (30,6%).

Pure peat as a fertilizer is valuable not enough, as it contained little nitrogen available to plants. To improve the quality of peat it must necessarily compost. The proper preparation of compost from peat is not inferior to animal manure.

Bird droppings. On the chemical composition of poultry manure is one of the best kinds of organic fertilizers. The most valuable is the chicken and pigeon droppings, less valuable - the duck and goose. With frequent introduction of manure in the soil accumulated nitrogen in nitrate form, so this fertilizer is better to plough at the fall evenly throughout the area. But the most effective bird droppings for use in liquid fertilizing. Prepare the solution tank is half filled with litter, and then pour water, close lid and insist 3-5 days. The solution was again diluted with water (1:10).

Green manure. It is an organic fertilizer is ploughed into the soil tall plant mass single- or multi-leguminous plants (spring pea, spring vetch, broad beans, lupines, seradelly) and phacelia, buckwheat, sunflower and others. By its action of green manure is almost equivalent fresh manure. Some green manure crops (lupine, buckwheat, mustard) increases the solubility and availability to plants immobile soil phosphate, and lupine can use the hard forms of potassium.

Composts. Composts prepared from different organic materials. Crop residues, are not affected by pests and diseases, bird droppings, manure and other materials are piled in a loose pile on a flat surface, put by layers of muck soil or peat.

Straw. Straw is a valuable source of nutrients. It is found that four tons of straw into the soil goes (kg): 3200 organic matter, 14-22 nitrogen, 3-7phosphorus, 22-25 potassium, 3-9 calcium, 2-7 magnesium per 1 hectare. Also enter elements such as sulfur, boron, copper, manganese, molybdenum, zinc, cobalt.

4.4 Manure use in organic farming

Manure are traditionally a major fertilizer in organic farming, ensuring the conservation and reproduction of soil fertility. The efficiency of fertilizer significantly increased when combined with other methods (crop rotation, green manure, intermediate crops, liming, etc.)

Traditionally, in organic farming manure on the fields usually uncomposted and composted state. However, in some countries there are restrictions on the use of raw manure in organic farming. For example, in the U.S. it is written in the instructions National Organic Program (NOP), which constitute the federal standard for organic production.

Raw manure is an excellent resource for organic production. It is a source of nutrients and organic matter, stimulates biological processes in soil, which form the soil fertility. However, there are a number of concerns in the application of manure associated with the production quality, the ambiguous impact on soil fertility, weed problems and environmental pollution.

Sometimes manure may contain contaminants such as residual hormones, antibiotics, pesticides, pathogens and other unwanted substances. Since many of them can be addressed through high-temperature composting, then this practice is recommended where the levels of organic pollutants present in small amounts. However, there also must be careful as *Salmonella* and *E. coli bacteria* can survive in composting. The possibility of transmitting diseases to man prevents the use of fresh manure (and even some compost) as a preplant fertilizer for vegetable crops - especially those that are usually eaten raw.

Organic substances are not the only contaminants found in the manure of livestock. Heavy metals can cause problems, especially where a large-scale industrial production take place.

It is known that improper use of raw manure may have a negative impact on quality of crops such as potatoes, cucumber, pumpkin, turnip and cabbage. In the decomposition of manure into the soil released chemical compounds such as skatole, indole, and other phenols, which give an unpleasant smell of vegetables. For this reason, fresh manure should not be used immediately prior to planting these crops.

The negative aspects of using fresh manure

- The content of the large amount of nitrogen in fresh manure may be at high standards of its submission could have the same effect as excessive use of nitrogen fertilizer: burn the root system of seedlings, reduced plant resistance to diseases and pests, reduce the quality of products, etc.

- Fresh manure is often rich in certain nutrients such as phosphorus or potassium. While these nutrients are of great benefit to the crops, but excessive use of manure can lead to contamination of groundwater. Surplus nutrients can also "bind" the other elements. A large amount of phosphorus in the soil affects the uptake by plants of copper and zinc, and potassium may limit the intake of boron, manganese, and even magnesium.

- Regular use of fresh manure can contribute to acidification of soil solution. In the decomposition of manure releases various organic acids, which increase the availability of minerals. If this is happening for a long time, this process can lead to a reduction in the soil of calcium and reduces the pH. Keep in mind that manure also supplies some calcium, but not enough to maintain the buffer soil (N. Kinsey, 1994).

- Application of fresh manure can cause environmental pollution (groundwater, ponds, lakes, rivers, etc.) that adversely affects human health.

- Fresh manure is a source of weed seeds. According to the Institute of feed into 1 ton of manure contains from 43 to 56 thousand of viable weed seeds (G.I. Bazdyrev, 2004). However, increasing contamination by manure application is also connected with the stimulating effect of fertilizer on seed and vegetative reproductive organs of weeds in the soil.

Composting manure in organic agriculture is largely eliminates the above-mentioned negative effects. A good compost is a "safe" fertilizer. There is virtually no free ammonia or soluble nitrates, and a large quantity of nitrogen bound in proteins, amino acids and other biological components. The remaining nutrients in the compost and stable, and low content of soluble salts does not cause a burn at the plant. That can be effectively used for growing vegetable crops.

The quality of compost depends on the technology of preparation and composition of feedstuffs.

Benefits of composting

- After composting, organic fertilizers are reduced in volume by 30-60%, which is much easier to work with them.
- In the fertilizer significantly reduced the number of weed seeds and pathogens.
- Reduces the number of flies in comparison with manure.
- Reduces or eliminates the biological fixation of nitrogen (immobilization), which occurs when making sawdust or straw in a pure form.
- Composting is also very useful for the processing of kitchen waste from crop residues, weeds and manure.

4.5 The use of straw in organic farming

One of the most popular organic fertiliser is animal manure, but not every organic farm can has manure in sufficient quantities. In addition, transport of manure has become a very expensive undertaking.

In these circumstances, the role of straw as organic fertilizer, which is compared with the manure is more environmentally friendly, in 3,4 times contains organic matter and has a cost of entry into the soil below, up to 7 times (G.V. Kolsanov, 2005; I.N. Zemlyanov, 2007).

Every ton of straw into the soil back 8.5 kg of nitrogen, 3.8 kg phosphorus, 13 – potassium, 4.2 - Calcium, Magnesium 0.7 kg and a range of trace elements that accumulate in the straw to a greater extent than in grain (iron - from 10 to 30 grams per ton, manganese - 15 to 70, copper - from 2 to 5, zinc - 20 to 50, molybdenum - from 0,2 to 0,4, and boron - from 2 to 5) (G.Y. Sergeev et al, 2006).

The advantage of straw used as a fertilizer, is high in organic matter, created on-site consumption (L.Y. Vernichenko, E.N. Mishustin, 1980; A.A. Golovach, D.V. Luzhinsky, 2007).

After applying of straw decreases the bulk density of soil, increasing the number of water-stable aggregates (A.F. Safonov, A.A. Alferov, 2002), as humic substances are highly cementing ability that causes the formation of water-stable soil structure.

Changes species composition of microorganisms. When making straw residues in the upper third of the arable layer parasitic microflora is replaced by saprophytic microflora consuming fresh plant residues. Cellulolytic microflora enriched bacteria that release mucus, which is weakly indestructible other soil microorganisms. Because of these mucins form aggregates, retains its structure in a median strip the whole summer period (L.Y. Varnichenko, E.N. Mishustin, 1980).

Numerous overseas studies have also indicated the important role of straw in soil nutrients (A.L. Black, 1973; E.L. Skidmore, J.B. Layton, D.V. Armbrust, M.L. Hooker, 1986), especially with the advent of No-Till (H. Blanco-Canqui, R. Lal, et al., 2006; G. Peterson, 2008).

However, despite the positive role of straw in the maintenance of soil fertility, many researchers point to the shortcomings of straw as fertilizer (B.A. Smirnov, S.V. Shchukin et al, 2005; G.V. Kolsanov, A.H. Kulikova, N.V. Khvostov, J.H. Zemlyanov, 2008).

Applying straw in the soil accompanied by such unwanted processes as immobilization (biological fixation), nitrogen (R.N. Ushakov, 2001), discharge of toxic substances in the decomposition of crop residues (A.R. Steynfort, 1983) and an increase of weeds (A.I. Puponin, 1991). In addition, the introduction of straw stimulates the development of certain types of soil microorganisms, which also produce toxins. All this could adversely affect soil fertility and crops.

Restriction of the use of fertilizers and herbicides in organic farming by using straw to neutralize the above-mentioned negative processes forced to seek other ways of solving problems. In this regard, consider the following conditions for effective use of organic fertilizers:

- Method of applying (mulching or ploughing into the soil)
- The type and moistening of soil.
- Weediness
- Time of applying (when and under what crop)

According to L.Y. Varnichenko and E.N. Mishustin (1980) under aerobic conditions, the decay of straw toxic substances accumulates less than anaerobic decomposition. In addition, the products of anaerobic fermentation of straw to inhibit the growth of seedlings of culture, and aerobic - stimulate.

In this regard, better plough the straw immediately after harvest and crushing in the upper, more aerated and microbiologically active soil layer (8-10 cm). Here, as contained in the straw decompose toxic products intensively and without secondary accumulation of harmful substances (L.Y. Varnichenko, E.N. Mishustin, 1980).

In addition to the ploughing of straw in the top layer of arable horizon, apply mulch the soil surface that helps keep moisture and protects the soil from erosion (A.R. Steynfort, 1983).

Abandonment of crop residues (including straw) on the soil surface as mulch is one of the fundamental elements of the technology No-Till, which has been used successfully in North and South America, Australia, Europe and Asia. According to numerous studies of this technology while leaving crop residues on the soil surface provides the accumulation of organic matter (B.A. Hooker, T.F. Morris, et al, 2005), absorbs the energy of raindrops and protect soil aggregates from demolition (G. Peterson, 2008), causes the development earthworms, which leads to improved soil physical properties (W.A. Dick, E.L. McCoy, W.M. Edwards, and R. Lal, 1991; S.J. Fonte, A.Y.Y. Kong, Chris van Kessel, P.F. Hendrix and J. Six, 2007).

This technology allows the placement of seeds in the soil, without mixing them with crop residues and thus avoid exposure to toxic degradation products (V.I. Kiryushin, 2007).

However, despite some successes, the technology of No-Till cannot be recognized as the benchmark (V.I. Kiryushin, 2006, 2007, I. Gureev, 2007), especially in the non-chernozem zone, since it does not take into account soil and climatic conditions - high rainfall , lower temperature, the difference between equilibrium and optimum density, contamination of weeds, etc. In these circumstances, the effective application of straw will determine the method and time of applying of the fertilizer into the soil. Need to avoid making straw before sowing crops (winter cereals). Better if the straw will be made in the summer (autumn) for the crop that goes to the green manure for next year. This will avoid loss of productivity of major crops and crop rotation will provide more effective weed control.

4.6 Role of green manure crops in organic farming

Information about the use of green manure crops to improve soil fertility and productivity of cultivated plants has its roots in antiquity. Chinese manuscripts indicate that the use of green manure fertilizer probably is more than 3000 years. Green manures were used in ancient Greece and Rome. Today, with the development of sustainable agricultural development interest in green manure fertilizer is increasing (Fred Magdoff and Harold van Es., 2010). Green manure is an essential element of organic farming.

As a green manure are mainly cultivated legumes - lupine, clover, vetch, rank, sainfoin, seradella, feed peas. In some cases, the use and leguminous crops (mustard, buckwheat, rye, etc.) or mixtures of legumes with cereals.

Beans and all legumes, alfalfa - a rich source of nitrogen, grow best on heavy soils.

Mustard and rape - enriches the soil with organic matter, phosphorus, sulfur. Germinate quickly. A good tool to control wireworm. Does not require for its development, good soil, but cannot serve as a precursor for crucifers because they hit some diseases.

Buckwheat - enriches the soil with phosphorus and potassium. Recommended for heavy soils.

Annual lupines - enrich the soil with phosphorus and nitrogen. Recommended for light soils, but can grow in heavy.

Oats - enriches the soil organic matter and potassium. Usually planted with peas.

Winter rye - are sown in summer after harvesting the main crop. It turn under in the spring at the height of the stems to 60 cm enrich soil with nitrogen and potassium, and improves the physical condition of the soil.

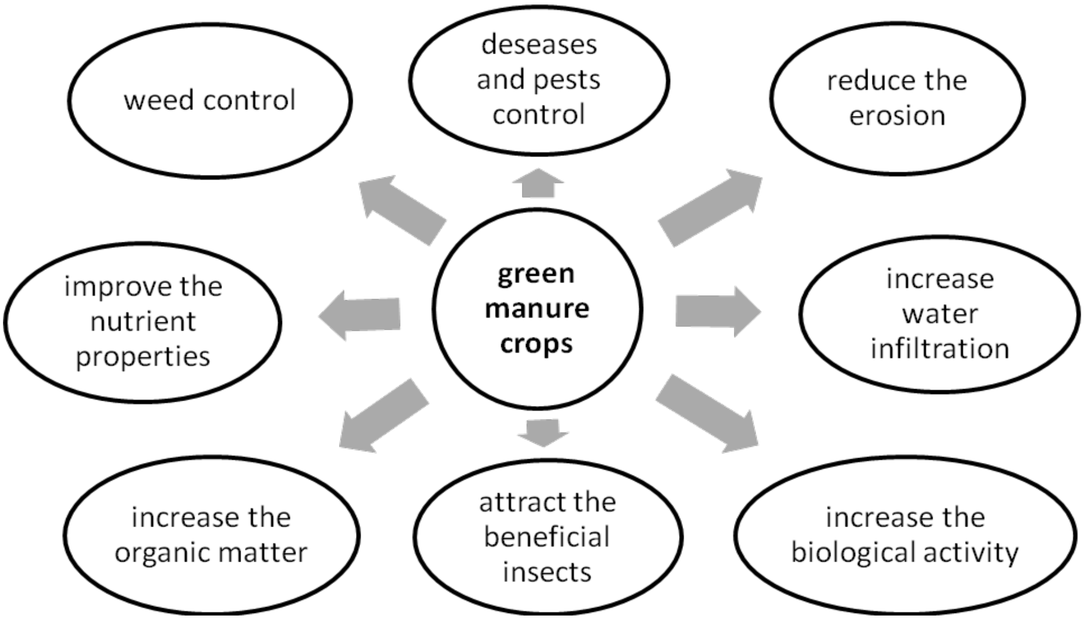


Figure 4.3 The advantages of using green manure fertilizer

Green manure, above all, is enriching the soil with nitrogen and organic matter. Often per hectare of arable land plow 35 - 45 tons of organic matter, containing 150 - 200 kg of nitrogen. Applying green manure in the soil is accumulated not only nitrogen but other nutrients. It is also important that when plowing green manure completely eliminated the accumulated losses of nitrogen in it. Green manure in the soil decomposes much faster than other organic fertilizer, rich in fiber.

Green manure lowers the acidity of the soil, reduces the mobility of aluminum, increases buffering, absorption capacity. When plowing the green mass of plants improves soil texture, bulk density decreases the arable layer and the density of the composition of the soil. It is very important because in this case eliminated the negative effects of topsoil compaction of heavy agricultural machinery. As a result of plowing of green manure significantly increased water permeability and water-holding capacity of soil, thereby reducing the runoff of precipitation and increases dramatically the moisture content in the soil.

Table 4.5 The content of main nutrients in green mass of green manure and manure, % (E.K. Alekseev)

Fertilizers	Nitrogen	Phosphorus	Potassium	Calcium
Manure mixed	0,50	0,24	0,55	0,70
Green mass of lupine	0,45	0,10	0,17	0,47
Green mass of sweet clover	0,77	0,05	0,19	0,90

As a result, dramatically improves the livelihoods of soil microorganisms. Microbiological processes in soil is much worse in the period of growth and development of green manure, and even the best conditions for the soil microflora generated after plowing green manure. This is due to the fact that they enrich the soil with humus, nitrogen, phosphorus and other macro- and micronutrients necessary for the development of microflora and plant nutrition. At the same time also is absorbed by soil microorganisms of nutrients, which dramatically reduces the possibility of their leaching, particularly nitrogen, into the lower soil horizons.

Green manure reduced field weediness and carry out phytosanitary role. All green manure increases the efficiency of making other fertilizers. As a result of the use of green manure increases crop yields of all crops and thereby increase the ability of soil conservation cover (A.N. Kashtanov, M.N. Zaslavsky, 1984).

In the decomposition of green manure plowed soil-ground and air enriched with carbonic acid, which promotes the transfer of soil phosphorus and other mineral nutrients in a digestible form for plants. The rate of decomposition of plant material depends on the depth of tillage, green manure age, size distribution of the soil. The greater the depth of setting and older plant, heavy granulometric composition of the soil, the slower the splits in her green manure mass, and vice versa (A.V. Peterburgkiy, 1967).

Thus, the use of green manure on eroded soils plowed up and has a complex effect, ensuring the restoration of their fertility and productivity. So, for some, every hectare of green manure crops in fallow fields non-chernozem zone gives an increase of grain yield of at least 1.0 ton per hectare (and its aftereffect).

The application of green manure fertilizer

Distinguish green manure crops alone (in pure form) and compacted (or mixed), solid and crank (rocker), undersowing and after harvested.

Pure green manure occupies a separate field rotation one season. These are also called crop fallow. The use of green manure fallow, i.e. pure green manure, it is interesting to poor soils. To speed up the cultivation of such soils green manure fertilizer is combined with mineral fertilizers, manure, various composts.

Pure green manure may occupy the field of 2 - 4 years in a row, if conducted reclaim the soil of the event. Such techniques are recommended for sandy humus soil on eroded areas before planting fruit trees and berry bushes on poor soils.

Pure green manure may take the field or part of the field (plot) and a shorter time. For example, annual lupine place after harvesting the main crop of rotation on a fallow before sowing of winter crops. Such a green manure crop is called *intermediate* or intercalary.

Green manure cannot occupy the entire area, only part of it in strips. Such a *crank (rocker)* crop at the site alternating bands of different width, occupied and not occupied by green manure. Moreover, the green mass of green manure used as fertiliser on the adjacent lane. Rocker cultivation of green manure are usually used between the rows of gardens, tea and citrus plantations. The same technique is used on slopes, placing the scenes across the slope to prevent water erosion. In this case, use a multi-lupines, astragalus, alfalfa, clover, etc. Sometimes combine solid and rocker culture of green manure. For example, cultivating sandy tracts in the non-chernozem zone, plot the first several years occupied a solid long-term culture of lupine. Then plowing so that plowed strips alternated with the headland. Plowed strip then used for food or feed crops, and fertilize them ukosnoy mass with bands, where they continue to grow lupine.

Compacted green manure crops are a co-cultivation at the site (field), the main crop and green manure. This technique allows to obtain a significant amount of green mass of green manure during the growth and maturation of the main crop. Immediately after harvesting this crop green manure fertilizer wrapped. In compacted crops important to exclude the mutual inhibition of green manure and the main crop, and most importantly, do not reduce the yield of the latter. To this end, culture is selected so that their root systems penetrate to different depths, and do not create competition with each other for the batteries. For example, yellow lupins sown forage with corn, oats, spring vetch as green fodder under the cover of winter rye and regrowth after mowing the use of these mixtures aftermath of lupines for green manure.

Depending on the time of sowing green manure - to harvesting or after harvesting the main crop - are distinguished *undersowing* or *after harvested green manure crop*. Undersowing green manure crops (lupine, clover, seradella etc.) undersow a previous main food crop. Green manure culture is developing a time under the cover of the main crop, thereby reducing the time of cultivation of green manure on the site. This method of cultivation of green manure is preferable in areas where the period between harvesting and planting green manure predecessor, the follow-fertilized culture is too short to grow a sufficient quantity of fertilizer to green weight. Apply undersowing green manure crop and when climatic conditions are unfavorable for the development of green manure in the early growing season. In the non-chernozem zone during cultivation in a couple undersow the previous spring plants (oats or barley) years of lupine. You can sow lupins and spring under winter crops, and ploughing through the year under the late spring crops.

In areas with warm, wet autumn and long cultivated after harvested green manure crop. They are used to fertilize the sugar-beet, fodder beet, maize and wheat.

In the humid subtropical Black sea coast is used winter (autumn) crops of green manure. They are distributed in Central Asia, Caucasus, Crimea, i.e. in regions with mild winters. Sow them in September - October, and the plough in the spring of next year. Depending on the conditions of autumn or winter crops of green manure can be as undersowing and after harvested.

Grown green mass of green manure crops is used differently depending on the conditions, objectives. To use green manure or all of the synthesized during the vegetative mass (like the green parts of plants and roots), or only a part. Therefore, there are three main forms of green manure: a complete, mowing, aftermath. *Complete* green manure crop includes the ploughing all mass of plants grown. *Mowing* green manure prepared by growing green mass at another site. Mowing mass transported to the fertilized field and plough. For this purpose, such as a pin field grown perennial grasses (mostly lupine) and fertilize its mowing mass adjacent field crop: the first mowing under winter crops, the second - a plough-land. The gardens mowing mass of green manure, resulting in between the rows, used for fertilizer around-trunk circles. Fertiliser effects of green manure mass is not inferior similar dose of manure. Mowing mass of green manure crop can be used in compost. To do this, it layers stacked in piles with corn straw, cotton stalks, river or pond mud, feces and composted in the usual way.

5 Crop rotations in modern agriculture

5.1 Crop rotation in Russia and in the world

Since ancient times was known for efficiency change crops in fields, but then no one could explain its cause. This was only possible with the development of chemistry, physics, biology and other sciences that laid the foundations of scientific farming.

Attempts to explain the reasons for crop improvement by changing crops in the fields have made: at the beginning of the XIX century Swiss botanist Augustin De Candolle - author of the theory of sanitary state; Albrecht Thayer - from the viewpoint of the humus of plant nutrition, which in the middle of the XIX century, rejected the German Justus Liebig agrochemist, who discovered the mineral nature of plant nutrition. With the discovery of nitrogen fixation of legumes (Gelrigel, 1886) was an explanation for their positive influence on subsequent crop yields. In the late XIX - early XX century was the development of the theory P.A. Kostycheva and V.R. Williams, in which all cultures were divided into improving and deteriorating soil structure. Also known theory “root changing” by V.G. Rotmistrov (1910), according to which the proposed alternate on the fields of culture, with deep and shallow root system.

However, these and other theories were not given a full explanation of the effectiveness of crop rotation as compared to permanent cultivation of agricultural crops. For the first time a comprehensive explanation given Russian scientist Academician D.N. Pryanishnikov (1943). He was an active promoter of “crop changing” and recognizes the multiplicity of reasons for crop rotation, and invited them to consider the complex, which consists of four groups: chemical, physical, biological and economic order.

In accordance with the classification of crop rotations, distinguish 3 types: field, forage, and special. In the field, most of the area occupied by cereals, potatoes and technical culture; forage - more than half the area allocated for fodder crops; special - growing crops that require certain conditions and technology of cultivation (vegetables, tobacco, hemp, cotton, rice, etc.) . The ratio of agricultural cultures and fallows types of crop rotations are divided into types: grain-fallow, grain-fallow-row crop, grain-grass, corn-row crops, grasslands, grass- row crop, green manure, row crop, etc.

Crop rotations with different crops products, dominating throughout the countries of Western Europe, the USA and Canada from the XVIII to the middle of XX century gave way to the grain-growing regions grain crop rotations without fallows (except for wheat areas of the United States and Canada, where the use of two or three-field fallow-grain crop rotations) in areas of intensive animal production - forage crop rotations, in suburban vegetable farms - specialized. In connection with the enhanced intensification of agriculture has been a general trend toward greater specialization and reduce the rotation cycle. In the eastern areas of the UK, where more than 100 years was applied Norfolk crop rotation, since the late 60-ies. 27% of farms covered by crops over 70% of arable land. Practice crop rotation with intermediate cultures (in Germany and several other Western European countries), which provide an opportunity to expand crops (30%) in the same area and

> ***Crop rotation** is called science-based alternation of agricultural crops and fallows in time and in the fields or only in time (G.I. Bazdyrev et al., 2008).*

keep the soil from breaking down in areas of abundant rainfall. To prevent soil erosion, soil protection crop rotation is introduced (in the U.S., Canada and several European countries). In small farms with a small area of arable land are limited to one crop rotation with minimal number of crops.

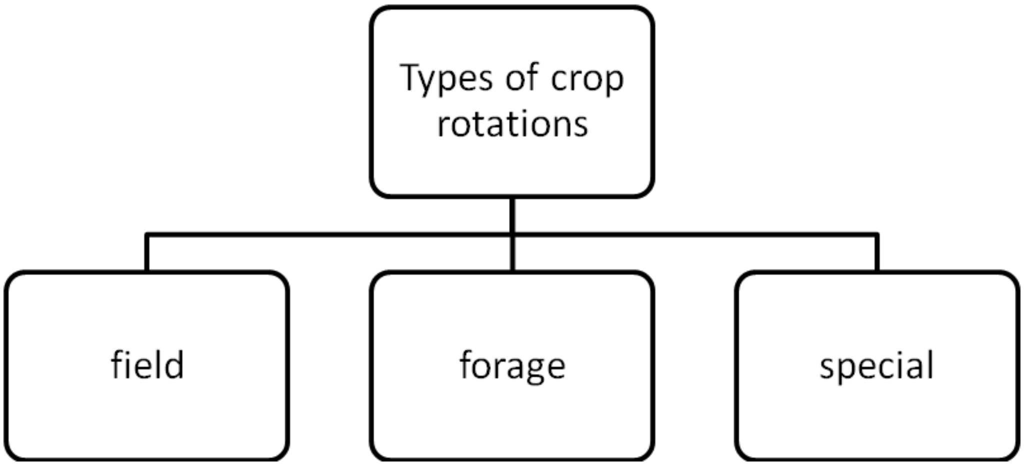


Figure 5.1 Types of crop rotations

In Asia and Africa crop rotation is practised for one year. Depending on the degree of soil moisture during a certain period of culture are chosen with different requirements to moisture.

In organic farming the right crop rotation is the basis for successful management. Since the ability to protect crops from diseases and weeds are limited, so their prevention through the rotation comes to the fore (B.R. Grigorian, 2009).

As nutrients for organic crop production comes mainly due to mineralization of soil organic matter, manure, compost, and intercropping, it is important to ensure a regular flow of rotation of a large amount of organic matter and organic matter has increased the soil itself.

Therefore, for cost-effective management of organic farming and output to specialized markets, U.S. farmers are forced to expand the diversity of cultivated crops (from five to ten species, and to market fresh vegetables - up to thirty).

The theoretical basis of the doctrine of crop rotation is one of the laws of scientific agriculture - the law of ***"Crop changing"****, which reads as follows: change of crops in the fields ceteris paribus better their permanent cultivation, and the effectiveness change of crops higher, the greater the differences in biology and technology of the growing of crops.*

However, due to the large variation in the sown areas of crops and frequent changes in their alternation due to changes in weather and market conditions, long-term planning of crop rotations for these farms is difficult.

For this reason, many farmers are replacing crops in the fields or sections do not follow any precise plan rotation cycle, and guided by the history of cropping and their physical and biological characteristics (the need for moisture, the amount of retained organic remains, competitive to weeds etc.). In this highly skilled organic farms tend to make a decision about crop rotation (such as going to market, and intermediate) for only one year in advance, because they consider longer-term planning useless due to frequent breakdowns of such plans.

Although long-term plans of alternating crops often do not follow, however, on many organic farms follow the general pattern of alternation. For example, farmers must plan to use in alternation with corn, soybeans and grain for several years of grass for hay, the same applies to the vegetable crop rotations. This period of "rest" under the hay crops can improve soil structure, to allow time for cleaning soil from pathogens and weeds, promotes the accumulation of nitrogen for subsequent forage crops.

Thus, the designing of crop rotation with only the general scheme of rotation greatly simplifies the process of decision-making producers of organic products in the U.S. In addition, the division of farms into small, have their own administrative offices, greatly facilitates the efficient allocation of agricultural crops in the fields every year, so it is easier to trace the history of the crop in each segment of each field. In addition, the problem of variegation fertility becomes possible to solve the selection of the appropriate culture (C.L. Mohler, 2001).

The central role of crop rotations in organic farming is highlighted by the important focus on rotation in many organic certification standards, hot example, in the United Kingdom (UK), the standards for plant production (including pastures) require a “multi-annual rotation programme” for building soil fertility and managing weeds, pests and diseases (F.G. Wijnands, 1999).

The structure of organic rotations generally consists of two parts. First, legumes are used as a soil fertility-increasing component, from yearly to multi-year crops, mainly in the form of forage legumes, with much less in the form of grain legumes (G. Herrmann, G. Plakolm, 1991) and, second, periods with non-legumes such as cereals, root crops or field vegetables, relying on the accumulation of humus, organic nitrogen and depleting the resources.

Thus, the main objectives of the crop rotations in organic farming are (G. Kahnt, E.R. Keller, U. Kopke, 1997):

- maintenance and improvement of soil fertility;
- maintenance and improvement of soil organic matter;
- maximisation of symbiotic N fixation through cultivation of forage and grain legumes;
- production of sufficient food and straw for animal husbandry;
- optimised UM of pre crop effect through crop with high gross margin;
- mobilisation of nutrients through crops, with high root density and root depth;
- control and reduction of pests and diseases;
- control of weed competition combined with gentle soil cultivation;
- improvement management and economic situation of the farm.

5.2 Ecological and economic role of crop rotations in organic agriculture

Crop rotation with its science-based change of crops in the fields is a model of a system solvution one of the major problems of modern farming systems - rational use of arable land. In science-based scheme of crop rotation is the possibility of efficient use of soil fertility, biological potential of crops and their diversity, agroclimatic resources - the heat and precipitation, agricultural machinery, manpower in order to obtain high yields and maintaining and improving soil fertility and protect of environment.

Particular importance rotation takes to solve ecological environmental problems. Crop rotation primarily is the basis of a properly designed system of soil and environmental land management in modern farming systems.

On the limits of the fields of crop rotation make buffer strips, shelterbelts are planted woodland, create a network of field roads, and organize a system of detention and storm water from melted snow, build irrigation systems with canals and ponds. Closely linked to the meadows and pastures, forests and other elements of agro-landscape, such a system of land use in combination with a complex anti-erosion measures provides reliable protection of soil from water erosion, and the environment - from pollution.

The causes of the need for rotation of crops:

Chemical causes are mainly related to differences in the chemical composition of the soil on the fields after the harvest of various crops as well as the cultures consume different amounts of soil nutrients in varying their ratio, and with different depths and different number of unequal organic remains.

For example, sugar beet, cabbage, corn silage consumed from the soil much more nitrogen than cereal crops. Legumes (clover, alfalfa, peas, vetch, lupine, soybeans, lentils, beans, chickpeas, peavine, etc.) leave significant reserves in soil nitrogen. Significantly more than other cultures consume phosphorus from the soil potatoes, legumes and winter cereals (wheat, rye). Potassium in large quantities from the soil consume potatoes, sugar beets, sunflowers, barley, oats, forage root crops, vegetable crops. Higher consumption of calcium, sulfur, magnesium, and other mineral elements differ in corn, potatoes, sugar beets and other row crops and legumes. Moreover, cultures differ in the degree of assimilation of soluble substances of the soil. Thus, the roots of lupine, buckwheat, oats, potatoes, sugar beets, mustard capable of using root exudates to dissolve and transfer to the available plant forms insoluble phosphates of the soil and rock phosphate, and sugar beet - can absorb soluble potassium compounds. By quantity of organic matter retained in soil, field crops are in the following descending order: perennial grasses - silage corn - winter cereal - spring cereals - legumes - potatoes.

Biological reasons - different relations of crops to other plants and animals, especially pathogens, insect pests, as well as weeds.

Strong development of specific weeds in the permanent crops, or monoculture. Particular danger cause weeds parasites (dodder clover - Cuscuta Trfolii, sunflower Broomrape - Orobanche Cumana). Accumulation and distribution of specific diseases - diseases of crop rotation (in flax - Fusarium, of cotton - Wilt, a sunflower - Downy mildew, the potato - late blight, scab, a cabbage - kil). Distribution of specific pests (sugar beet, oats, potatoes - nematodes; for grain - bug bug, grain scoops, etc.). Adverse allelopathic effects - through the provision of plants or products of decomposition of the roots of toxic substances. Change the microflora under the influence of plants - right rotation contributes to the development of certain groups of soil microorganisms that are able to suppress the less competitive parasites. The correct spatial or geographic distribution of crops, as many pests, diseases and weeds can easily migrate if the field will be occupied by neighboring sister cultures.

Physical reasons - the influence of different groups of crops on physical properties and soil moisture after the harvest.

For example, long-term cultivation of root crops may lead to the destruction of soil structure, and this leads to the development of erosion processes, resulting in lost nutrients, soil fertility decreases. Must also be considered draining soil in growing crops with a strong root system (sunflower, corn), especially when the subsequent culture requires a certain reserve of moisture before sowing.

Economic reasons - has a potential to discharge peaks of field work and management of manpower and equipment.

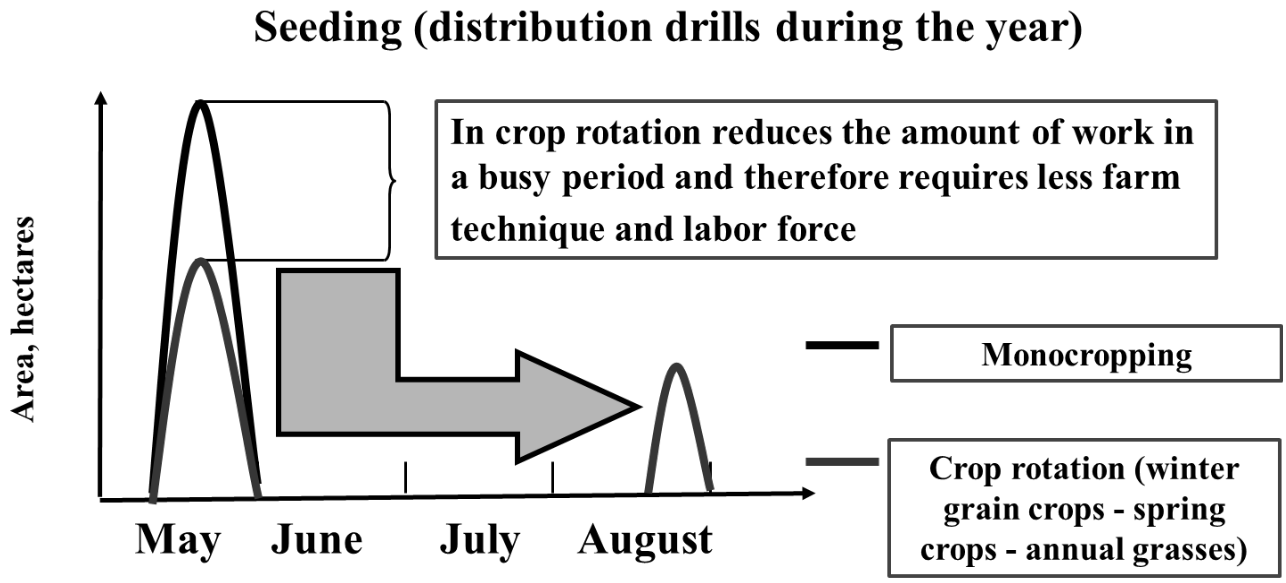


Figure 5.2 Congestion seeders in monocropping farm and in crop rotation

In each case the reasons may vary. However, the main reasons so far are biological.

Empirically found that not all cultures are equally responsive to crop rotation. Conventionally been divided into 3 groups:

1. Poorly responsive to crop rotation (corn, potatoes, hemp, rice, cotton).
2. Moderately responsive to crop rotation (winter wheat and spring wheat, winter rye, barley, oats, millet, buckwheat, potatoes, carrots and a few others).
3. React strongly to crop rotation (sugar beet, sunflower, flax, peas, vetch, beans, clover, and some vegetables: cabbage, red beet, tomato, peppers, eggplant, cucumber, essential oil).

Crop rotations play an important role in ensuring high productivity and sustainability of agriculture. It is as follows:

1. Crop rotation in relation to the different needs of crops in the elements of nutrition and varying degrees of involvement in their accumulation in soil biological nitrogen and organic matter provides a more efficient use and restoration of soil fertility.

2. When using crop rotation are improving the physical properties of the soil, improves its resistance to erosion. This is explained by the different capacity, type of root system and the characteristics of cultivated crops.

3. Crop rotation provides a higher level of phytosanitary condition of the fields and reduces the contamination of soil and crops. Many crops in permanent cultivation, and even when they are often to return to the original field is strongly affected by various diseases caused by fungi, bacteria and viruses.

4. Crop rotation provides higher yield of cultivated crops and greater profitability of the industry.

5. With the need to reduce using of chemical fertilizers or refusal from them in order to produce environmentally friendly products crop rotation can dramatically reduce the cost of chemical nutrients (fertilizers), without reducing crop yields.

In organic crop rotations the grain legumes should not exceed a proportion of 33%. Forage legumes, if cultivated in mixtures of clover and/or alfalfa and grass species, can achieve mixtures up to 50%. Because of incompatibilities, soilborne diseases and other factors, higher proportions of legumes can cause serious yield losses in a long-term perspective of rotations (B. Freyer, 2003).

Under favourable conditions forage legumes can be integrated into the rotation as undersowing in the preceding cereals. If the performance of the undersowing crop is poor, it should be replaced by a stubble crop sown after cereal harvest. Cover crops may be best suited when winter crops are substitute by spring crops. The time-span between pre-crop harvest and subsequent crop sowing allows sufficient time for accurate seedbed preparation, intensive mechanical weeding it necessary, and substantial root development and above-ground biomass tor soil protection. In response to the needs of different farm types, the proportion of the various crop groups used on the rotation will vary slightly. Mixed farms with ruminants produce mainly rough fodder that can be part of the rotation of between 30 and 50% grass clover or grass- alfalfa mixtures. Monogastric animals such as poultry and pigs are mainly fed by grains of legumes and cereals. Therefore, the proportions of legumes and cereals are shifting more to cereals and from forage to grain legumes. On arable farms the need for forage legumes is diminishing from the economical point of view. But from the perspective of sustainability, these farms should stay on at least a one-year set-aside system (P. Fragstein, 1996; P. Fragstein, P. Niemsdorff, B. Geyer, H.J. Reents, 2004).

In regions where rainfall is lower and/or less reliable, such as in Western Australia, simpler rotations with longer pasture or fallow phases are more likely. If the soil is heavier, with better nutrient and water retention, a suitable organic crop rotation would be pasture (vetch or medic Medicago spp. hay) > pasture > wheat > chickpeas > fallow > wheat. However, on lighter sandier soils, the rotation would consist of pasture > pasture (green manure) > wheat > oats or simply pasture > pasture > wheat (S. McCoy, G. Parlevliet, 2001).

Additional benefits derived from cover cropping include weed and disease suppression. Approaches for managing weeds are discussed below; however, the main mechanism of weed suppression by cover crops appears to be resource competition, rather than factors such as allelopathy (W. Bond, A.C. Grundy, 2001).

The outcome of a farm survey of 140 farmers clearly showed that thistles (Cirsium arvense) tended to become a serious problem on farms with a high proportion of cereals and summer-annual crops in the rotation (>60%). On farms with a high percentage of clover, alfalfa and other mowable crops (~20%) thistles were not reported as critical (H. Bohm, A. Verschwele, 2004).

Also, a decline prevalence phytopathogens, for example, replacing the sugar beet or oats by clover-grass mixture (K. Baeumer, 1992).

Thus, protecting soil from erosion, reducing the degree of infestation and contamination of crops and soil, optimizing the use of nutrients and moisture by crops, crop rotation to effectively reduce the chemical pollution of the environment, as this prevents the rivers, lakes, ponds, groundwater by fertilizers, pesticides, growth regulators and other chemicals used in agriculture. And this is of utmost ecological importance of crop rotation, especially in organic farming, not allowing the use of these substances.

5.3 Modern methods projecting of crop rotations

Rational land use planning of arable land - the basis of design efficiency of farming and farming systems as a whole.

Land management on arable lands in Russia are still pursuing the organization of crop rotation with designing fields according to crop rotation schemes designed and prospective business plans in order to ensure the alternation of agricultural cultures and fallows not only in time at each field, but also in the fields on the farm.

When farm land management in general and on croplands in particular provides for leveling the soil fertility of individual sites that make up the field and the fields included in the crop rotation. The need for such a transformation of soil due to existing principles of land management on arable lands in the designing of crop rotations.

Principles of design crop rotations fields:

1. Dimension of the field (recommended ratio of 5/3).
2. Correct configuration of the field (recommended parallel longitudinal sides, with angles 90-130^0).
3. Equal-field (allowed deviation of the field area from the average by 10-12%).
4. Uniformity characteristics of the soil of the field (admits up to 16% of the area of the field sites with the characteristics of indicators, not controlled by man, due to the genesis of the soil - that is a natural soil-forming process: grading, level and nature of wetting, depth and power of gley and podzolic horizons, slope steepness and exposure, etc.).
5. Allowed to have among the fields of the same crop rotation undetermined number of fields with different characteristics of soil caused not only by the values of agrochemical indices, but also on indicators which are not controlled by man. Transformation of soil on these fields may require a large expenditure of energy without any hope for their return, even in deep perspective.

The main conditions that stipulate the principles for the non-chernozem zone of soil, especially sod-podzolic, are: large complex (contrast) soil on indicators of fertility due to soil genesis, small area of fields, and fragmentation of natural and artificial barriers.

In this regard, the practice of farming non-chernozem zone, especially on sod-podzolic soils, crop rotations for decades, and generally not being developed, even in farms with a high level of agriculture the principle of alternation of cultivated plants observed only in time at each «work area of the field» (contour) with uniform soil characteristics. Crop rotation in the fields, as a rule, accept the chaotic shape. As a result, you cannot carry out systematic work on the expanded reproduction of soil fertility and increase yields of agricultural crops. In the adaptive landscape agriculture, these principles came into direct conflict with the possibility of placing adapted to each trace agrolandscape crops and varieties and their cultivation of differentiated technologies, as well as with the market relations of production. Consequently, holding land in arable lands, using these methods and organization of crop rotations on these principles do not comply with the adaptive-landscape systems of agriculture-based energy resource and ecological balance.

Therefore it makes sense to replace existing methods of land management in the organization of crop rotation on arable lands by one method – «Contour-landscape» and the principles – by «the principle of uniformity of soil», due to the genesis, within the working area (outline) of arable land to the organization of crop rotation just in time to observance of the principle of alternation of cultivated plants:

1. Leading crops (food, technology or any kind of vegetable crops - leading) should be placed on the best predecessors, because leading crop determine the specialization of farm and to a large extent the level of its economy.

2. Winter crops (wheat, rye, barley) should be placed on such precursors, which allow their crops to save enough of moisture for uniform germination and normal development of the autumn. Best meet this condition, the fallows - bare and covered by crops, early harvested crops.

3. Early spring crops (wheat, barley, oats, etc.) should be placed on the predecessors to allow a basic soil tillage in the autumn, and thereby enable the sowing to the earliest possible time in spring.

4. Predecessors «Recovery» of soil fertility (fallows, fertilized row crops, legumes, annual and perennial grasses) should be evenly placed on the rotation cycle. Impermissible accommodation, except in special cases, directly to each other (eg, bare fallow - legumes).

5. Intensive moisture consuming crops from deep soil layers (sunflower, sugar beet, perennial grasses) in the areas of insufficient moisture should not follow each other.

6. The same crops and the crops of similar biological features with common pests and diseases (cultures incompatible) should be returned to its original location until a certain period.

7. Under fallow, should be given more weedy, depleted fields.

8. In the orcharding, horticulture and berry crop rotations for the cultivation of good stocks and seedlings include row crops (fodder, vegetables and melons), perennial grasses, crops and fallow.
9. To protect the soil from water erosion (which can be dangerous if slope steepness > 5 °) in crop rotations are eliminated fallow, which also applies to vegetable crops in relation to their watering.

The scientific basis of the principle of land management («the principle of uniformity of soil»), is the response uniformity of the soil and plants on the human impacts of technological nature (variety of tillage, fertilizer, etc.). And at the heart of the development schemes of crop rotation on the following principles of their construction:

1. *The principle of adaptability*. Includes correspondence of crops cultivated in crop rotation, the local soil and climatic conditions and future crop pattern specific farm.
2. *The principle of biological and economic feasibility*. Determines the possibility of using a crop rotation of winter or spring forms of cereals, fallows, pure or mixed crops of annual or perennial grass, or undersowing crops, sowing intermediate crops, green manure crops, etc.
3. *Principle of crop changing*. Based on the law the law of «Crop changing» and assumes an annual change of cultures from different economic and biological groups differ significantly on the biology and cultivation techniques.
4. *The principle of periodicity.* Calls for compliance with the return time to the same crop to it's the same place of cultivation.
5. *The principle of compatibility and selfcompatibility*. Determines the possibility of use for major crops predecessors of the same economic and biological group or repeat their crops. For example, the sowing of spring crops after winter or after spring crops of another species, barley after spring wheat, oats, or after, etc., as well as re-sowing of winter or spring wheat after a bare fallow, repeated crops of corn, potato, rice in special circumstances of cultivation. This principle does not allow cropping of a family friend after another.
6. *Sealing principle of arable land*. Intended to include in rotations of crops intercropping to increase the utilization of arable land. Realized under conditions of intensive farming in areas of sufficient moisture or irrigated lands for the organization of the permanent green fodder and green manuring. In the southern areas of Russia may receive two full harvests of grains, tubers and other products.
7. *The principle of specialization.* Provides for the ultimate science-based saturation crop rotation of one or more cultures from the same biological groups. Realized under conditions of intensive farming to build specialized grain, sugar beet, potato and other crop rotations.

Thus, it is better to introduce scientifically based alternation of agricultural cultures just in time. Structure of sown areas, there may be stable, according to a promising business plan, and may be dynamic in response to changing market conditions, weather conditions and internal needs of the economy. Consequently, its scientifically based crop rotation just in time for each field (work area) is more dynamic and plastic; more fully meets not only the principles of energy-saving resources, environmental safety systems of agriculture, but also the relations of production and market requirements of organic farming.

Each field of arable land (working area), thus should have:

1. Complete characterization of the main indicators of the genesis (mechanical structure of the soil, the level and nature of the moisture, slope exposure, humus-accumulation layer, the power and depth of clay horizon, stoniness) and the agrochemical parameters;

Table 5.1 Adaptability of crops to different conditions agrolandscape non-chernozem zone of the Russian Federation

Crops	Soils	Moisture soil condition
Root vegetables (beets, turnips, carrots), potatoes, buckwheat, lupine, alfalfa	Clay and clay loam, sand and sandy loam	Normal
Cereals (winter wheat, spring wheat, barley), flax, clover, grass for hay	Clay and clay loam, heavy clayey	Normal
Winter rye	Clay and clay loam, heavy clayey, sand and sandy loam	Normal, temporarily excessively wet (gleyic)
Oats, fodder beet, peas	Medium clay and clay loam	Normal
Corn in the rotation and permanent plots	Clay and clay loam, heavy clayey, sloping lands south and south-eastern exposure to 3^0 and the lower part of the slope with fertile soil	Normal
A mixture of vetch and oats for green fodder	Clay and clay loam, sowing culture in physical maturity of the soil at a depth of seeding and vegetation period of 50-55 days	Normal, temporarily excessively wet (gleyic)

Source: B.A. Smirnov, 2008

2. Adapted crops (Table 5.1) and varieties (under specific conditions can be determined by the dynamics of long-term yields). Crops must be placed at the best precursors (Table 5.2):

Table 5.2 Precursors of major crops (V.N. Stepanov)

Crops	**Precursors (from top to satisfactory)**
Winter cereals: wheat, rye, barley, triticale	Bare fallow (in arid regions) or covered by crop (in the areas of sufficient moisture), perennial grasses and annual grasses, peas and other legumes, early potatoes, corn for green fodder and silage, grain corne, winter wheat (North Caucasus).
Early spring: spring wheat	Bare fallow (West and east. Siberia), legumes, winter, spring wheat (reseeding) of wheat after a bare fallow.
Early spring crops: oats, barley	Row crops (except sunflower), legumes, winter, spring wheat.
Late spring: millet, sorghum, buckwheat	Row crops (except sunflower), legumes, winter cereals.
Late spring: corn	Winter wheat, legumes, potatoes, sugar beets, corn (again).
Late spring: Rice	Perennial grasses (clover, alfalfa), legumes (soybeans, peas), grains (wheat, barley), rice (again 2-3 years).
Legumes: peas, beans, soy beans, peavine, rape	Row crops, winter and early spring.
Potato	Winter wheat, legumes, perennial grasses turnover.

Sugar beets and other root vegetables (turnips)	Winter wheat, sugar beets (in the irrigation districts), spring wheat after a bare fallow (West Siberia), potatoes (non-chernozem zone).
Sunflover	Winter wheat, legumes, spring wheat and barley. Returns to its original place not earlier than after 6-7 years.
Flax	Perennial grasses, peas, potatoes, winter. Returns to its original place not earlier than after 5-6 years.
Cotton	1-2-3 years using of alfalfa, cotton (reseeding 4-7 years)
Hemp	2-3 years using of alfalfa.
Annual legumes and grass mixture (lupine, vetch)	Row crops, winter and spring cereals.
Cover crops for perennial legumes (clover, alfalfa, sainfoin) and clover grass mixtures	Different mixtures of forage crops early grades mowing, spring cereals, winter.
Intermediate culture	Early harvested crops
Chicory	Bare fallow and covered by crop, winter wheat, potatoes, green peas.
Vegetable	
Green peas	Winter, spring cereals, chicory.
Onion	Bare fallow, potatoes, turn perennial grasses, carrots, cucumbers, tomatoes, winter cereals.
Beetroot	A mixture of annual forage crops, carrots, potatoes, cabbage and fodder beet.
Carrot	A mixture of annual forage crops, potatoes, cabbage and fodder beets, carrots.
Cabbage	Perennial grasses, winter wheat and forage crops for silage and green manure, carrots, potatoes, cabbage after perennial herbs, beetroot, onion, cucumber, tomato.
Cucumber	Perennial grasses, cabbage, potatoes early, tomatoes, onions, carrots, cucumbers.

3. Adapted resource-saving, ecologically balanced growing technology. In this case, you first need to consider: the frequency of the possible return of culture to its place:

- winter crops (rye and wheat): the non-chernozem and steppe zones should be possible to refrain from re-planting (due to the development of root rot). In areas of the steppe zone - allowed re-sowing in wet years, especially if the first winter wheat after bare fallow.

- spring cereals (wheat, barley and oats) - re-sowing is not desirable (due to the development of nematodes). You can sow them in a year, alternating with cultivated and legumes. During the development of crop rotation - is permissible, but not more than 2 consecutive years at a high level of nutrition. Allowed in the steppe regions of Siberia and the Volga region, but not more than 2 years under condition of the first wheat after bare fallow.

- corn and hemp - it is possible to sow 4-6 years to re-excited and often turn to their original location.

- sunflower - not recommended to return to their original location before 8 years (the spread of broomrape, white rot).

- flax - unstable to fusarium species return to their original location, not earlier than after 5-6 years. Flax after flax - is unacceptable. For resistance to fusarium varieties of flax may be re-sown and return to its former place in 3-4 years.
- cotton - can withstand repeated crops of 5-7 years, then you have to finish sowing alfalfa for 3-4 years (the development of wilt).
- sugar beet - beet growing areas (forest-steppe zone, gray forest soil and chernozem) reseeding are not allowed (powdery mildew, cercosporosis, heart rot, weevil). You can return to its former place no sooner than 3-4 years.
- potatoes in a specialized potato crop rotations - are allowed 2, maximum 3-year planting. For re-planting of seed potatoes are not allowed. With a high degree of infestation of potato (phytophthora, scab, wireworms, etc.) - replanting as unacceptable.
- legumes - recommended to return to its former place in 3-4 years. Repeated plantings are not allowed.
- vegetables - recommended to return to its former place in 3-4 years (the development of hernia).
- essential oil crops - to return to their original location can be in 2-3 years.

Thus, the organization of crop rotation just in time for the concrete conditions of agro-landscape - is “Agrotechnical rod” for agromeliorative, organizational and economic measures to optimize the use of each field (working area) of arable land, and it system could become the basis of organic farming.

5.4 The role of intermediate crops (cover, catch crops) in organic agriculture

Most of the major crop of crop rotation took the field for a time, which is only 50-70% of the total duration of the period of plant vegetation as possible. For example, in many areas of non-chernozem zone after harvest of winter and spring grain crop fields are empty for more than two months of warm summer-fall period. During this time, falling 100-150 mm or more rainfall, the amount of biologically active temperature reaches 1000 °C, 30-40% of agroclimatic resources of the entire warm period. Many more resources in the agro-climatic regions of sufficient moisture, and in irrigated areas of southern regions of the country.

To use these resources, uses intermediate (cover, catch) crops. Its divide: after harvesting intermediate crops, after mowing intermediate crops, winter intermediate crops, undersowing intermediate crops, implementing the principle of compaction of crops. They also serve as an integral part of organic agriculture.

Winter intermediate crops are crops of winter sowing (rye, triticale, vetch, hairy, etc.), remove the spring to feed the animals with the obligatory seeding after harvesting the main after mowing crop. The latter do not belong to the intermediate crops, because it use most of the warm

Intermediate (cover, catch) crops *are crops grown on arable land in a period of time, free from the cultivation of a main crop of rotation.*

season, and because, unlike the after mowing intermediate crops called the the main after mowing crop.

After harvesting intermediate crops called crop, sown in summer and autumn, after harvesting the main crop, and giving the yield in year of sowing. It may be, for example, turnip or annual lupine sown in late July - early August after harvesting.

After mowing intermediate crops are sown in late summer after harvest (mow) annuals, perennials and other crops destined for animal feed and harvested in the autumn of that year.

On terms of sowing, germination conditions and harvesting time after mowing intermediate crops are close to the after harvesting intermediate crops but its variety is wider because forage grasses often mow before starting the harvesting of cereals.

Undersowing intermediate crops is crop sown in the spring under the cover of cereals and other crops and harvested in the fall of that year. An example such crop can be serradella (bird's-foot), sow for barley.

Found that, in the forest zone of Russia for after and after mowing intermediate crops suitable oats, peas, lupine, kale, turnip, white mustard, winter and spring rape, fatseliya, oilseed radish, winter rape and other fast-growing and resistant to frost culture. In the southern areas used for this purpose corn, sunflower, buckwheat, Sudan grass, millet, sorghum, panic and other late spring crops.

As winter intermediate crops in many areas can cultivate winter rye, winter wheat, winter barley, winter triticale, winter vetch, peas, wintering oats, and winter rape. These crops make good use of agroclimatic resources of the autumn-winter and spring, are resistant to over-wintering, are rapidly growing in early spring gives high yields of green mass.

As undersowing intermediate cropping in northern areas are plant different kinds of clover, winter vetch, clover, serradella, lupine annual or perennial, annual ryegrass in the southern regions - clover, sainfoin, clover-year, Sudan grass. These crops are sown under cover crops or annual grasses.

The value of Intermediate crops

1. Intermediate crops can make full use of arable land (the coefficient of its use is 1.38), solar heat, precipitation, and in addition to the yield of main crops can get a yield of feed and other products with the same field. On irrigated and drained areas of arable land, these cultures provide an opportunity to make better use of water and costly hydroengineering facilities, equipment and labor.

2. Intermediate crops occupy an important place in the strengthening of livestock forage. First of all, they are one of the main functions of a permanent green fodder recept, as it provides food during those periods of the year, when the main fodder crops have not yet reached the stern of ripeness (spring) or have already mowed. With sufficient supply of animals with fresh green forage intermediate crops are high-quality raw material for fodder in the stall period (early hay, silage, hay, vitamin flour, pellets and briquettes).

3. A special role is becoming intermediate crops in organic farming and specialized as a phytosanitary. The sharp difference in biology and farming practices from the main crop of rotation, they are the elements of the crop rotation with high specialization, its increase of biological diversity.

4. Intermediate crops, as a reserve fodder are at the same time a large agrotechnical, organizational and economic importance. With proper cultivation increases their farming standards and improving soil fertility. They are an important source of high quality organic (green) manure.

Green manuring in a rotation contributes to a higher level of biodiversity in time and space. The first term clearly indicates the expectations for N-conserving activities in the crops used, mainly fast-growing crucifers and grass species. The second term is similar, but also emphasises the soil conservation action of covering the soil with vegetation. Undersowing or, more recently introduced, living mulch systems increase the complexity of a growing system by combining different partners at the same time (L.K. Paine, H. Harrison, 1993).

The potential benefits of intercropping include improvements in soil fertility, resource capture, pest and disease control, weed management and risk management. However, intercropping requires good farm management skills to satisfy the full agronomic needs of more than one crop (J. Theunissen, 1997).

Intercropping systems using in situ mulch crops have been widely tested, particularly in the United States of America. Using leguminous cover crops in cabbage were found soil fertility and weed control benefits but also noted that interspecific competition was a major problem. Intercropping may be especially suitable for row crops with poor competitiveness against weeds (L.O. Brandsaeter, H. Riley, 2002).

Within the European Union (EU), specific programs facilitate the use of one-year set-aside crop mixtures. This is often managed within a biennial or longer grass clover crop, out of which one year is financed by subsidies and not fed to animals. Similar effects, although on a lower level, can be expected from a one-year forage crop by excluding the last cut as roughage and providing additional biomass as C and organic N supplied to the soil (J. Heb, 1993).

The one-year green manuring is most valuable as a humus source, whereas the quickly degraded biomass of green manure provides more nutrients and energy sources for soil organisms and improves the fertil ity for the subsequent crop (M. Schonbeck, H. Stephen, R. DeGregorio et al., 1993).

Forage legumes were found to be more efficient in supplying N to subsequent wheat (Triticum aestivurn) crops than grain legumes such as pea (Pisurn spp.) or vetch (Vicia spp.) (J. Evans, G. Scott, D. Lemerle et al., 2003).

However the improvement in soil structure by the root residues of the preceding forage legumes was more important than the impact of the N supply alone (M. Wivstad, B. Bath et al., 2003).

Alleiopathic properties of glucosinolate-containing crucifers are highly relevant for their phytosanhary effects against the incidence of soilbome diseases (L. Lazzari, L.M. Manici, 2001; B.J. Smith, J.A. Kirkegaard, G.N. Howe, 2004).

Buckwheat as green manure may act similarly against various weeds as a result of the presence of gallic acid (Z. Iqbal, S. Hiradate et al., 2003).

Infestations by root- knot nematodes, a severe pest in vegetable cultivation, can be reduced by various green manures such as radish (A. Nucifora, E. Schiliro et al., 1998) and sudan grass (Cl.S. Abawi, C. Vogel, 2000).

Whereas F.G. Wijnands (1999) reported very limited use of green manure crops as part of crop rotations in Dutch organic farms (3 of 68 interviewed farmers), German surveys in organic agricultural (G. Rahmann et al., 2004) and vegetable holdings (P. Fragstein et al., 2004) revealed that 60% of arable farms and 63% of vegetable farms used cover crops or undersowing. In a survey of organic farmers In the USA, the most common (72%) soil fertility management practice reported was the use of cover crops (E. Walz, 1999).

Thus, the positive effect of intermediate crops on the physical, chemical, biological indicators of soil fertility increases crop rotation, especially with the specialization of farming, unfavorable for the organization of normal crop rotation on the fields.

Soil conservation and ecological function of intermediate crops exceptionally high. Protecting soil from erosion and reducing the number of pests, diseases and weeds in the fields, its help to reduce the chemical inputs on the field (pesticides), soil erosion and thus protect the environment from pollution, which is essential for organic farming.

6 Plant protection in organic agriculture

6.1 Control strategies in conventional farming and organic farming, their efficiency and ecological safety

Modern methods of plant protection from pests, weeds and diseases in most parts of world agriculture, focused on the use of pesticides. Thereof there is a contamination by the toxic residual of a crop of environment, decrease in a regulating role of beneficial components of agrobiocenoses (entomophages, pollinators, auks, etc.). This contributes to the formation of resistant populations of harmful species to applied pesticides.

Currently registered in Russia are 28 species of arthropod pests, 6 species of pathogens and 6 species of weeds which revealed the formation of resistant populations or races to pesticides of different fytosanitory appointment (Г.И. Сухорученко, 2001).

Formation of resistance of harmful organisms to used protection frames of plants is one of most acute problems of modern agriculture as leads to sharp decrease in efficacy of protective measures and augmentation of volumes of use of pesticides that promotes the further destabilization of fytosanitory conditions in agroecosystems (Г.И. Сухорученко, 2001). This also contributes to rapid adaptation of pests and pathogens to commonly cultivated resistant varieties, created on genetically unimodal basis.

Monitoring of the phytosanitary situation in the crops of major crops has shown that under present conditions there is the widespread expansion of the range of the most dangerous pests, pathogens and weeds, and the role of previously economically unimportant species. One reason is the formation of secondary reservations and hotbeds of polyphagous pests and weeds on abandoned croplands. So in the last decade, the situation dramatically escalated with rodents in grain crops, row crops, perennial grasses and pastures in the southern regions of Russia. To prevent losses from this group of pests annually a rodenticide treatment of farmland to more than 50% of populated areas. Great economic importance again becomes locusts. Since the territory in the steppe regions of the Volga region, Northern Caucasus, Southern Urals and Western Siberia are inhabited in the mass as a gregarious locusts (Calliptamus italicus, Locusta migratoria), and nongregarious species. (В.И. Долженко и др., 2003). According to official data only from 2000-2002 against these species of processed annually about 2 million hectares of farm-land.

Separately to highlight the situation developing with the Colorado potato beetle. In Russia in the last 15 years there has been a significant spread of this species in the north and east. The exacerbation of an ecological situation with the pest in many other regions of potato growing and vegetable growing of Russia and the adjacent states of the former USSR where population of potato beetle reaches 100 % of the areas, and losses of a crop of tubers invoked by it even is noted at carrying out of protective measures quite often reach 30 % and more. One of the reasons is the formation of highly resistant populations of Colorado potato beetle used to organophosphate and pyrethroid insecticides (В.А. Павлюшин, 2005).

Therefore today, in many countries of the world, application of pesticides in agriculture decreases.

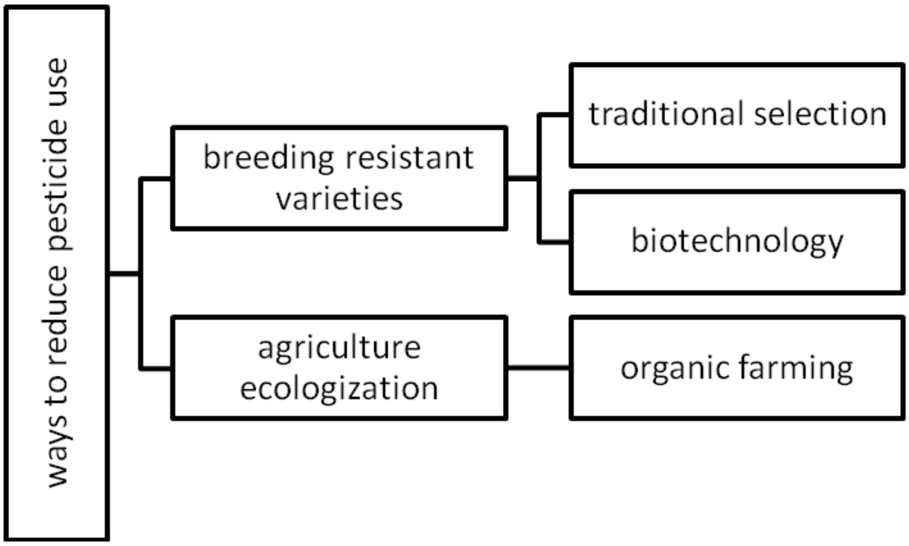


Figure 6.1 The main ways to reduce pesticide use

Application of pesticides in conventional agriculture can be lowered both at the expense of achievement in selection of crops, and at the expense of perfection not chemical methods (mechanical, biological) (fig. 6.1.).

Selection can reduce the need for fungicides and insecticides, but has little effect on the use of herbicides, in fact, in certain cases it may even encourage their more widespread use of herbicide resistance through breeding varieties. For this cause special attention is given to perfection of not chemical methods, especially at a weed control that is a basis of ecologization of farm-production.

In natural ecosystems, low susceptibility to pests has often been associated with high levels of biodiversity (G. Peterson et al. 1998), that can be used for managing agro-ecosystems. Organic farming in contrast to conventional is characterized by great biological diversity. The reasons for this difference in biodiversity are manifold, but in particular, the:

- absence of herbicides reduces detrimental effects on various microbial species;
- absence of synthetic nematicides and insecticides reduces broad-spectrum effects on beneficial fauna;
- absence of general lumigants reduces broad-spectrum activity on all soil life;
- absence of easily available plant nutrients reduces the selective enhancement of fast-growing microorganisms, and
- addition of various plant and animal-derived organic materials enhances the soil food web and, indirectly, the above-ground food web.

In addition, organic farmers frequently purposefully plant strips of controlled natural vegetation, which affects not only above-ground biodiversity, but also soil biodiversity. If higher biodiversity in agroecosystems reduces invasibility, then we can expect a reduced spread of pests and diseases in organic compared to conventional farms.

It is known that organic farming often leads to lowering the productivity of crops (Section 1.5). However, reducing crop yields often associated with lack of nutrients than the low efficiency of plant protection products. Consequently, many of the methods of plant protection designed for organic agriculture, may be used for conventional agriculture. In turn, the control methods adopted in the conventional agriculture such as soil tillage, variety selection, planting dates, etc. also available for organic producers.

Problems Crop protection in organic and conventional farming have common roots. Approaches to crop protection in organic agriculture differ widely among growers globally and regionally. At one end of the spectrum, organic growers use substitution-based approaches in large-scale operations to capture premium prices in a niche market. At the other end, resource-poor farmers producing subsistence crops use, by default, pest regulation tactics based on traditional knowledge. Organic growers at both ends of the spectrum are less motivated by environmental and public health considerations than are those growers that have formed the philosophical centre of organic agriculture movements in various parts of the world. For these growers, organic agriculture differs fundamentally from conventional agriculture, not in terms of the pest and disease challenges that face crop production or solely in the range of tactics used by growers, but in the conceptual approaches that frame crop management strategies (Deborah Letourneau, 2006).

Too often, descriptions of the conceptual approaches in conventional and organic agriculture are overly simplified (A. Trewavas 2004). Conventional pest control can no longer be characterised as the reliance on scheduled applications of broad-spectrum pesticides (biocides, insecticides, fungicides, herbicides). Best practices in conventional agriculture incorporate a wide range of tactics, including pest monitoring and judicious use and timing of selective pesticides, selection of insect and disease-resistant cultivars, and cultural controls such as crop rotation and crop residue destruction. By the same token, organic agriculture is more than conventional agriculture minus synthetic fertilizer and pesticide inputs. While some organic growers do simply substitute manure for fertilizer and botanically derived pesticides for synthetic pesticides - more often, organic practices involve a wide range of soil management and cropping practices that maintain ecosystem health and foster ecosystem services (M.A. Altieri 1999).

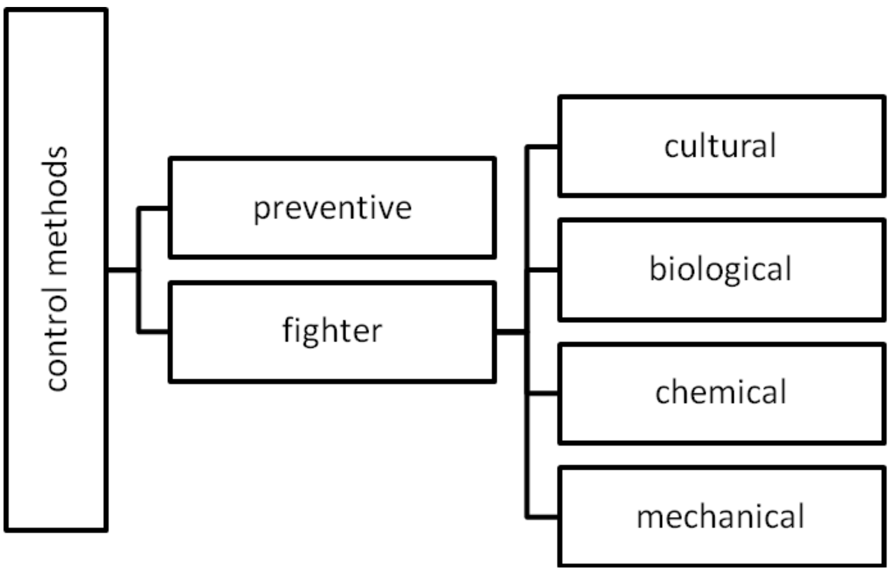


Figure 6.2 Brief classification techniques to control pests, weeds and diseases of crops in conven-tional agriculture

One of basic distinctions between management of organic and conventional systems is arrangement of priorities in the decision of tasks of agriculture. Traditional agriculture is often focused on solving short term problems, such as increased productivity through the use of synthetic fertilizers or herbicides. Whereas, organic systems strategically use other approach which involves creating conditions that will ensure the sustainability of the agroecosystem (E.A. Stockdale, et al. 2001).

Cultural method is based on general and specific farming techniques by which pose environmental conditions unfavorable for development and reproduction of pests and increase the self-protecting properties of plants (soil treatment, physical destruction, etc.).

Biological method based on the use of predatory and parasitic insects (entomophagous), predatory mites, microorganisms, nematodes, birds, mammals and others to suppress or reduce the number of pests.

Chemical method based on the use of pesticides toxic to pests**.**

Mechanical method is based on the barrage and catching grooves, catching bands, various devices for catching vermin, etc.

In the 2nd half of the 40th of the XX century in relation to identifying the negative side of the chemical method in the conventional agriculture has increased attention to integrated plant protection, under which in the narrow sense, understanding the combination of cultural, chemical and biological methods in order to maximize preservation of beneficial entomophagous insects in the broader - a rational combination of all methods the construction of a differentiated system of protective measures.

Table 6.1 Relative reliance on different crop protection practices in organic and conventional agriculture to reduce crop invasion by pests and pathogens

Methods and approaches	Specific practices	Organic	Conventional
Colonisation prevention			
Sanitation	Pathogen-free seed, debris destruction, flaming, steaming (fumigation in conventional farming)	Common	Common
Temporal asynchrony	Поздние или ранние посадки или сбор урожая, что препятствует распространению вредных организмов	Common	Common
Inconducive conditions	Crop rotation, repellent cultivars, soil suppressiveness by organic amendments, temperature control and repellents in storage facilities and greenhouses	Common	Common
Synthetic chemical barrier	preventive foliar sprays with synthetic insecticides, nematicides, acaricides, anticoagulants, fumigants, fungicides or bactericides; botanical pesticides containing petroleum derivatives	Absent	Common
Spatial isolation	Crops sown distant from pest or pathogen hosts, weeds, non-crop hosts removed, barrier crops or natural strips, physically distant	Occasional	Rare

	from all coloniser pools		
Disrupt colonisers	Mating confusion, trap cropping, sterile male releases, and low voltage 'soft electrons' for insects, fences, trapping, netting for birds and mammals, sealant, reflective tape and startling sound for birds and rodents	Occasional	Occasional
Population regulation			
Host plant resistance	Suboptimal plant quality (low fertilisation), resistant cultivars, crop spacing, plant extracts or other repellents or hormones applied to stored products	Common	Common
Genetically modified resistance	Genetically modified crops with Bacillus thuringiens'ts toxins, proteinase inhibitors, various forms of resistance against diseases	Absent	Common in some countries
Intercropping	Mixed cultivars, mixed cropping, strip cropping, green manures, incorporation of repellent plants	Common	Occasional
Competition	Enhanced herbivore and microbial diversity to reduce the proportional representation of injurious taxa	Common	Rare
tnsectary vegetation or predator resources	Flowering plants in field margins, strips, islands, hedgerows, cover crops, bat and owl nesting sites, bird perches to attract and retain natutal enemies in the crop field	Common	Occasional
Conservation	Avoid use of biocides that disrupt natural enemies and competitors	Common	Occasional
Unsuitable environment	Ventilation, humidity, and temperature control (greenhouses and storage facilities), humidity control by irrigation, irradiation	Common	Common
Curatives (at population level)			
Synthetic pesticides	Various systemic and contact insecticides, mollusdcides, acaricides and fungicides, pyrethroids	Absent	Common
Organics	Soaps, oils, compost teas	Common	Rare
Inorganics	Sulfur dust and sprays, diatomaceous earth, micronutrients (Si or Zn), iron phosphate, C02, IM2, copper hydroxide, Bordeaux mixture	Common In some countries	Common
Botanicals	Plant extracts without petroleum-based synergists (pyrethrum, rotenone, nicotine, neem, horsetail)	Rare	Rare
Inundative biological control	Predators (e.g. ladybirds, predatory mites), parasitoids (e.g. egg parasitoids, larval parasitic wasps and flies), bacteria (e.g. Batillus thuringiensis, B. subtilis), entomopathic and nematopathic fungi (e.g. Entomophthora, Trichoder-	Occasional	Occasional

	ma, Beauveria and Verticillium), viruses (e.g. arboviruses)		
Physical removal	Trapping, vacuuming, handpicking, hunting	Occasional	Rare
Physico-mechanical effect	Tillage, burning, of, flooding, frozen out smoothing, etc.	Common	Common

Source: Deborah Letourneau, 2002

The success of the integrated methods of controlling in inorganic systems of production often grows out of application of the whole arsenal of effective synthetic pesticides. In addition, many techniques for inorganic cultures developed on the basis use of materials control pests (eg, the use of genetic varieties of the modified crops, insecticidal seed treatment).

Unlike the traditional approach, organic systems of agriculture to rely on cultural and biological methods of controlling, and practically excludes use of synthetic chemical materials in production of crops. Genetically modified cultures it is not supposed.

In practice, Integrated Pest Management has evolved into the science of using field scouting protocols and research-based economic thresholds to determine whether and when to use a pesticide. When pest population or visible pest damage reaches a level at which economically significant losses of crop yield or quality are likely in the absence of control measures, a pesticide is applied. While this «conventional Integrated Pest Management» approach can significantly reduce pesticide use, it still relies on chemicals as the primary tool in pest management.

The limited vision of conventional IPM has led sustainable agriculture researchers to take the next step into biologically-based Integrated Pest Management, or biointensive Integrated Pest Management (R. Dufour, 2001), which returns to the ecological roots of the original Integrated Pest Management concept. Biointensive Integrated Pest Management:

- Emphasizes proactive (preventive) strategies, adopted in planning the cropping system, to minimize opportunities for pests to become a problem.
- Utilizes living organisms, ecosystem processes and cultural practices to prevent and manage pests whenever practical.
- Employs the least toxic materials and least ecologically-disruptive tactics when reactive (control) measures are needed to deal with an outbreak.

An important difference between Conventional IPM and Biointensive IPM is that the emphasis in the latter is placed on enhancing the biological processes that enhance the overall sustainability agrophytocenoses (M. Schonbeck, 2007). At the same time, Biointensive IPM includes many components that are in the Conventional IPM (monitoring, the use of economic thresholds, record keeping and planning).

6.2 Weed control in organic farming

Weeds are the most costly category of agricultural pests. Worldwide, weeds cause more yield loss and add more to farmers' production costs than insect pests, crop pathogens, root-feeding nematodes, or warm-blooded pests (rodents, birds, deer, and other large grazers).

Annually the agriculture of the Russian Federation loses from pests, diseases and weeds about 100 million tons in recalculation on grain from which tons to 40 million it is necessary on weeds. Losses from the weeds of cereals ranged from 20 to 25%, and tilled and vegetable crops - up to 50% (Ю.А, Спиридонов, 2008). Weeds have tremendous seed production and can remain viable in soil for decades (З.И. Порохня, И.Д. Кобяков, 2006; И.В. Дудкин, З.М. Шмат, 2007). Weeds dry up the root layer of soil and make large amounts of nutrients introduced with fertilizers (О.В. Мельникова, 2008). So apply fertilizer on heavily infestation areas cannot provide a complete action, and increase their doses stimulate greater development of weeds (И.В. Дудкин, З.М. Шмат, 2006; Г.Ш. Турсумбекова, 2006; О.В. Мельникова, 2008).

As the principles and rules of organic farming excludes the use of most herbicides, it is considered to be weeds most serious obstacle to the successful transition to organic production (Š. Týr, at al., 2009), and the effective control of weeds in organic farming.

Currently, there are two strategies for planning up prevention and control of weeds (K. Hurle, 1997):

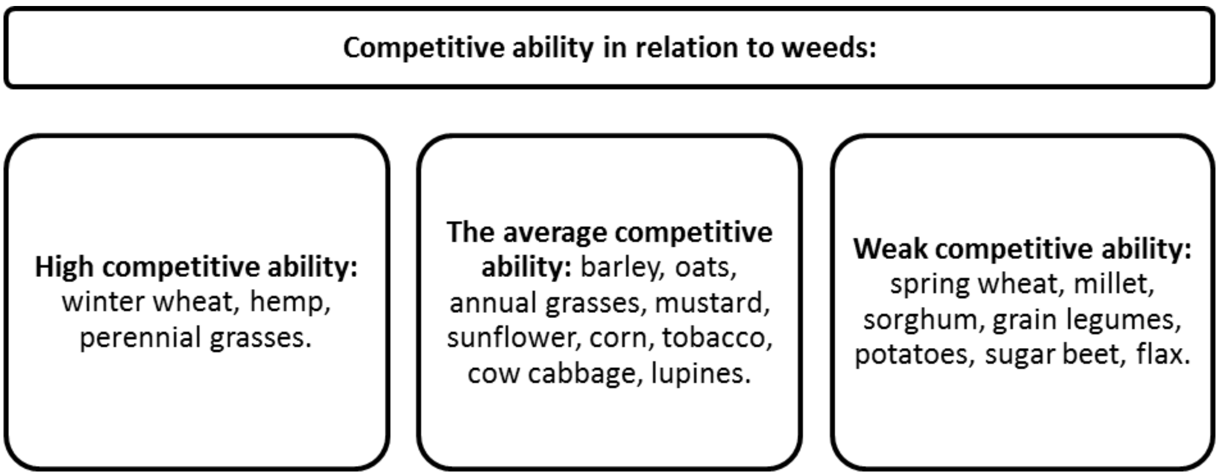
Strategy «Control at any cost»

The aim of this concept is to keep pest as low as possible to minimize crop losses and prevented a potential increase in pests. This concept was of a global character to the middle of last century. Despite modern advances in technology, the possibilities of this strategy is limited.

Strategy «Economic threshold»

The basis of this concept is economic threshold: the loss of crop in terms of value equal to the value of the costs of preventing such losses. Currently identified thresholds for many of the major weeds, pests and diseases in crops of major crops. It is important to bear in mind that the allowable threshold is not increased infestation (prevalence) of crops following crops of the field.

However, weeds are not distributed evenly across the field, both in terms of individual species and their abundance, which considerably complicates the answer to the question: whether an threshold of harmfulness. Therefore, some researchers have isolated the third direction control weeds component agrophytocenoses: **ecological threshold** (K. Hurle, 1997) или **ecological- economic threshold** (Б.Д. Кирюшин и др., 2008).



The concept of ecological threshold is much more complicated and goes beyond the reasonable economic questions: what degree of contamination can happen? In addition, we must answer the question: what level of contamination we need?

For last 40 years the species composition of weeds in the Western Europe was reduced to 20-40 %, and potential seediness (stores of seeds of weeds in soil) has fallen from 30-50 to 1-5 thousand pieces/m^2. Reduction in species composition was due to simplification or specialization of crop rotation, high doses of nitrogen fertilizers and thickened crops, and reducing the stock of weeds in the soil - the introduction of effective technologies for cultivation. Ecologists consider this tendency in evolution of weedy population negative. Weeds to a certain extent provide biological diversity agrophytocenoses, since each plant association are many other organisms. If in a subsequent drop in productivity of arable land will be due to the biological diversity, then there is the need to introduce ecological threshold (Б.Д. Ктрюшин и др., 2008).

The functions performed by weeds:

- Protecting soil from erosion
- Due to a more developed root system, ability to return to topsoil leached elements of mineral nutrition
- Replenishment of organic matter
- Source of feed for farm animals
- Conserve nutrients
- Habitat for microorganisms, insects and animals
- Restores biological diversity

Damage caused by weeds:

- Competing with the cultural rasteniyaimi for light, water, nutrients and space
- Emit toxic for cultivated plant substances (allelopathy)
- Are the source for possible infection, disease and pests
- Can cause lodging of crops
- Reduce an exit and quality of animal production
- Damage to human health
- Complicate the conduct of field work

The presence of ecological understanding of the role of weeds is the basis for constructing effective management practices in organic agriculture. But, despite it weeds were and remain the basic problem in organic farming (M. Lacko-Bartosova and et al, 2001). Costly weed problems develop when three conditions occur together:

- A large weed seed bank (including both seeds and vegetative propagules) in the soil
- A susceptible crop
- A favourable environment for weed growth

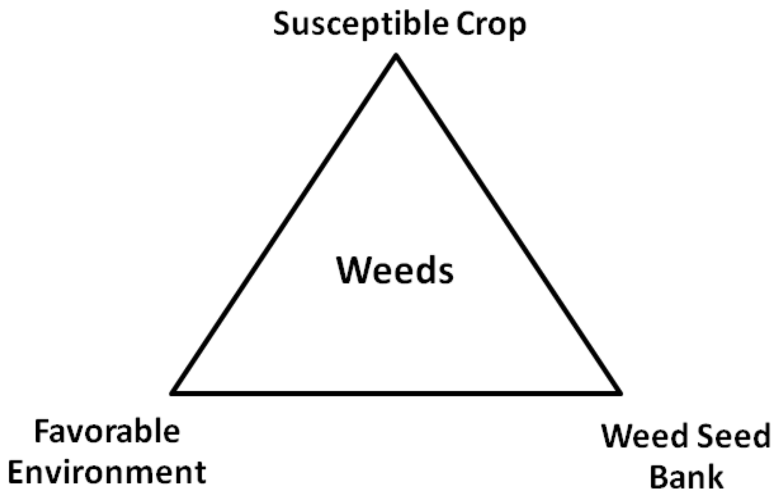


Figure 6.3 The combination of conditions that determine the harmfulness of weeds (M. Schonbeck, 2011)

On the organic farm, weed problems are minimized through an integrated combination of tactics that:

- Enhance crop competitiveness and tolerance to weed pressure.
- Remove or curtail weed growth in the critical early stages of crop development.
- Reduce the weed seed bank in the soil.

Thus, the purpose of an ecological approach is to reduce the number of weeds, the delay time of occurrence of weeds relative to crop plants, limiting the production and distribution of seeds, and make maximum use of available resources of crops (M. Liebman, C. L. Mohler, 2001).

Organic farmers use a wide diversity of tools of control of weeds in organic farming which can be divided is conditional on: cultural where the special attention is given to mechanical, physical methods and biological, including a crop rotation, catch crops, an allelopathy etc.

Cultural methods of weed control are cheaper than other methods and tools. In addition, these methods are combined with conventional tillage activities, which are necessary for growing crops. Cultural methods are based on the preparation of soil, which are necessary for growing crops.

Effective mechanical control of the number of weeds requires presence of the conforming machinery complex. They must correspond to the species of crops, phases of plant development, processing methods, and type of infestation. Thus, the mechanical methods of weed control should be integrated into the program, which in turn merged with other ecological management methods.

Tillage. Tillage has several functions, including the removal of existing weeds. Tillage done after harvest of one crop and prior to planting the next crop serves several functions, including incorporation of crop residues, cover crops, and soil amendments; removal of existing weed growth; and preparation of a seedbed for planting. Field preparation often consists of a **primary tillage** operation to break sod, loosen or invert soil, and kill existing vegetation; and a **secondary tillage** pass to form a seedbed of desired fineness. Because of the potential adverse impacts of tillage on soil quality, many farmers attempt to reduce tillage, either by making only a single pass before planting, restricting soil disturbance to only part of the field area (strip, ridge, or zone tillage), or minimizing the intensity of disturbance through shallow or noninversion tillage.

Primary tillage tools include the moldboard (turn) plow, chisel plow, disk plows (such as heavy offset disk), rotary spaders, and rotary tillers operated near their maximum depth. Secondary tillage tools include disk harrow (light disk), field cultivator, springtooth harrow, spiketooth harrow, and rotary tillers.

For weed control in crops is carried out as Inter-row cultivators: shovels and sweeps, rolling cultivators, and rotary tillers. With this method of weed control conventional and organic agriculture are very similar.

Competently constructed tillage system is ensured by creating an enabling environment for rapid and simultaneous seed germination and vegetative reproductive organs of weeds - a **provocation**; grinding implements processing of underground organs of perennial weeds in the main the depth of their root system followed by deep segments plowing the soil - **asphyxiation** (*Agropyron repens*), regular pruning of plants tillage implements in order to spare their consumption of nutrients and the subsequent death - **malnutrition** (*Sonchus arvensis, Cirsium arvense*).

An important feature of weed control in organic farming is more widespread use of Inter-row cultivators. For this purpose, various tools used (Fig. 6.4).

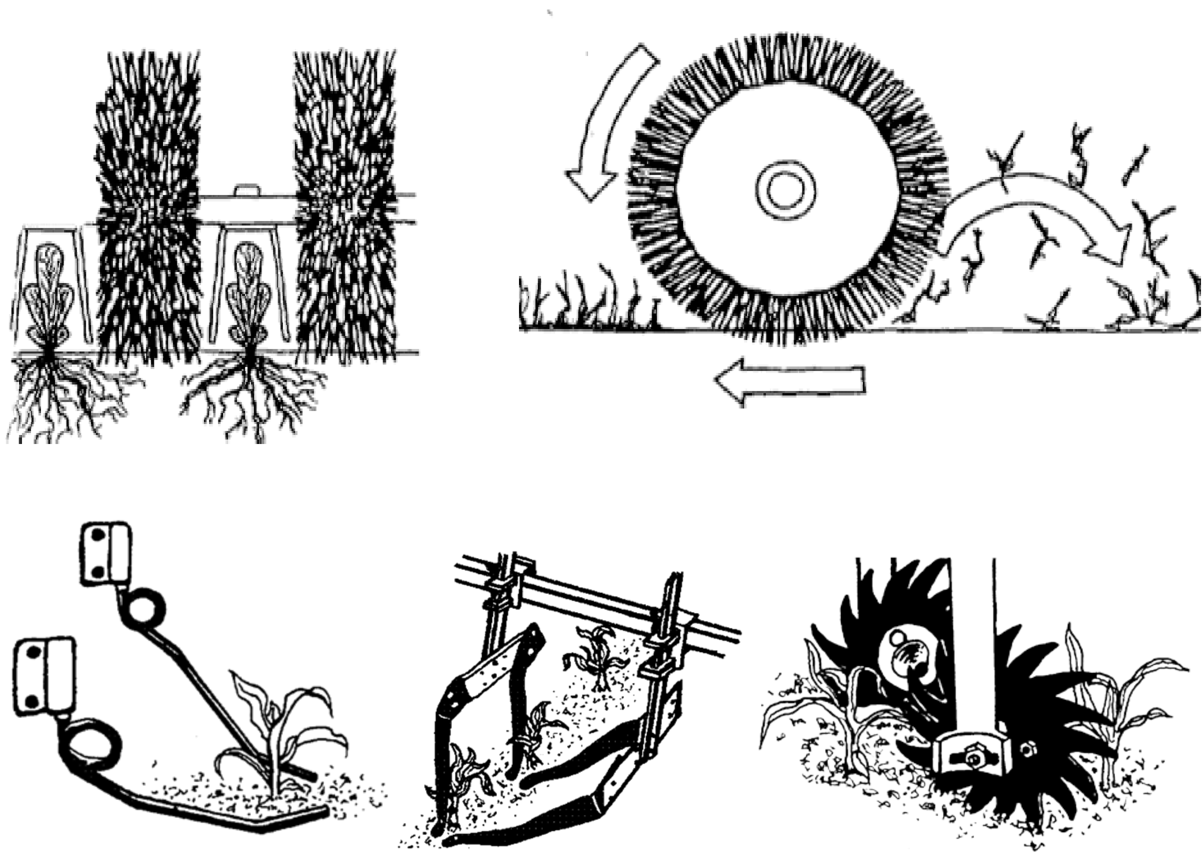


Figure 6.4 Tools Inter-row cultivators (C.L. Mohler, 2001b)

Thus at transition to organic agriculture it is necessary to find balance between minimisation of the soil cultivation providing conservation of soil fertility, and augmentation of weediness of crops.

Method of drying in the sun. With a shallow tillage weed rhizomes are extracted to the soil surface, where they affect the sun's rays. The method is effective only in dry and hot weather.

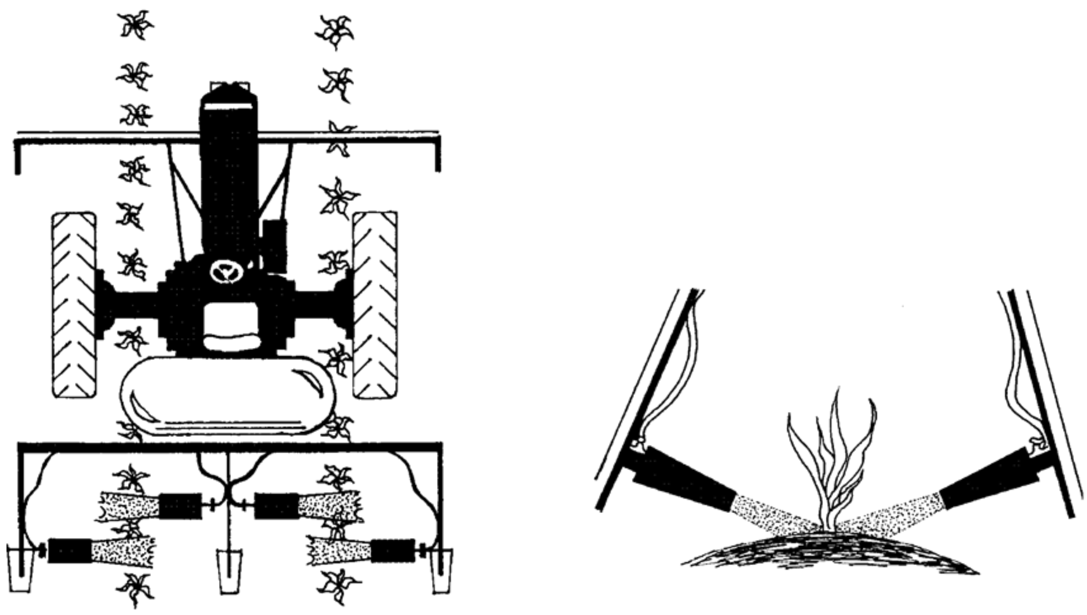
Freezing. With deep plowing in the late autumn on the soil surface is extracted underground organs of perennial weeds to make them at low temperatures have lost viability.

Method of a mowing of weeds. This method is simple, but effective. Farmers use rotary (bush-hog), sicklebar, or flail mowers to manage weeds in pastures, field margins, and sometimes in crop fields themselves. Whereas mowing simply removes top growth, leaving stubble of an inch to several inches in height, it can nevertheless have a significant impact on certain weeds. Some annual weeds are fairly mowing-susceptible and can be prevented from setting seed by one or two mowings, and even the growth and vegetative reproduction of perennial weeds can be restricted by timely or repeated mowing.

Three potential uses for mowing as part of integrated weed management in vegetable crops include between-row, over-the-top, and post-harvest mowing. When additional cultivation is not desired because of crop developmental stage or soil quality considerations, mowing weeds between rows of an established vegetable crop may be sufficient to prevent crop yield reductions and to reduce weed seed production. Examples might include mowing weeds just before cucurbit vegetables vine out, or between rows of snap beans, corn, or other vigorous crops a couple weeks before canopy closure. When weeds grow above the canopy of a low-growing crop like sweet potatoes or peanuts, some farmers mow just above the crop canopy to eliminate shading and seed set by the taller weeds. Finally, mowing rather than tillage after crop harvest can interrupt weed seed production without disturbing the soil or the habitat of ground beetles and other weed seed predators.

Thermal methods. Many vegetable growers use propane-fueled flame weeders - backpack or tractor-mounted - to kill small weeds just prior to crop emergence (full field flaming), or between crop rows (using shields to protect crops from the heat). Organic growers often flame a stale seedbed to remove emerged weeds without additional soil disturbance, just before or just after planting the crop. Flame weeders equipped with a flame hood or shield concentrate the heat on the target weeds, and are therefore more energy efficient.

A few crops can tolerate within-row flaming at certain developmental stages, such as corn and onions that are several inches tall (growing points are protected within the plant structure), and cotton (whose stem is woody and resistant). The flame is directed toward the soil surface from either side of the row. The goal is not to “burn” the weeds, but to subject them to a *brief* exposure to intense heat, just sufficient to disrupt cell membranes and cause the weed to dehydrate and die in a few days. Flaming is most effective and energy-efficient on small weeds up to two inches tall (S. Diver, 2002).



A B

Figure 6.5 In-row flame weeder (A) – View from above; (B) – View from rear for one row (C. L. Mohler, 2001b)

Other modes of thermal weed control include the infrared heater, and hot water and steam weeders, all of which eliminate the potential fire hazards associated with flame weeders in dry conditions, especially in the presence of mulch or dry residues (T. Astatkie et al., 2007). The infrared weeder directs the propane flame at a ceramic or metal plate, which radiates the heat onto the weeds. It can be effective, but requires several times more energy as direct flame. Hot water and steam units require hauling considerable volumes of water (от 9000 до 11000 л/га) into the field, and may control weeds less effectively than flame or infrared. (S. Parish, 1989).

Using microwave cure. Heating the soil by **microwave cure** frequency reduces the appearance of weeds on the soil surface, but is impractical in field conditions.

Using discharge weeders. Electric discharge weeders are used primarily to kill escapes in lowgrowing row crops like sugar beet and soybean. They operate by bringing a high-voltage electrode into contact with weeds that stick up above the crop canopy. Electrical resistance of the weeds causes vaporization of fluids, which disrupts tissues (C. Vigneault, D.L. Benoit & N.B. McLaughlin, 1990). The proportion of weeds controlled decreases with weed density because more pathways for energy discharge result in a lower energy dose per plant. Energy use increases with weed density, which makes electrical discharge systems impractical as a primary weed management tool. However, energy use for electric discharge weeding and herbicides was similar for low-density populations (e.g., 5 m2) that escaped other management measures.

Mulches. Organic mulches such as hay, straw, tree leaves, and wood shavings keep light-responsive weed seeds in the dark, physically hinder emergence of weed seedlings (Fig. 6.5), and can provide shelter for ground beetles and other weed seed consumers. They also conserve soil moisture for crop production, maintain good soil tilth, prevent surface crusting, feed soil life, and sometimes provide slow-release nutrients. About three or four inches of hay or straw mulch can greatly reduce the emergence of broadleaf weed seedlings. Organic mulches are less effective against grassy weeds, and usually do not significantly hinder the emergence of perennial weeds from rootstocks, tubers, rhizomes, or bulbs.

One limitation for organic mulch is that manual application of mulch materials may be too labor-intensive for multiacre plantings. Bale choppers have been developed to mechanize application of hay or straw between wide-spaced crop rows or beds. Another approach to mulching at the farm scale has been the production of *in situ* mulch in the form of high biomass cover crops. This entails no-till cover crop management and vegetable planting, which are most feasible where existing weed pressure is light to moderate, perennial weeds are scarce, and a transplanted or large-seeded vegetable will be grown in the cover crop mulch. Rollers, roll-crimpers, flail mowers, and undercutters are used to convert the mature cover crop into *in situ* mulch at the farm scale, leaving residues either chopped fine enough (flail mowing) or oriented parallel to future crops rows to permit mechanized planting. Gardeners can cut cover crops with a scythe, sickle, or weed whacker, and plant vegetables manually with a spade, trowel, or dibble.

Living mulches consisting of low-growing cover crops between cash crop rows are most workable for perennial fruit crops, especially tree fruits and grapes. Living mulches usually compete too strongly with vegetables, resulting in yield losses.

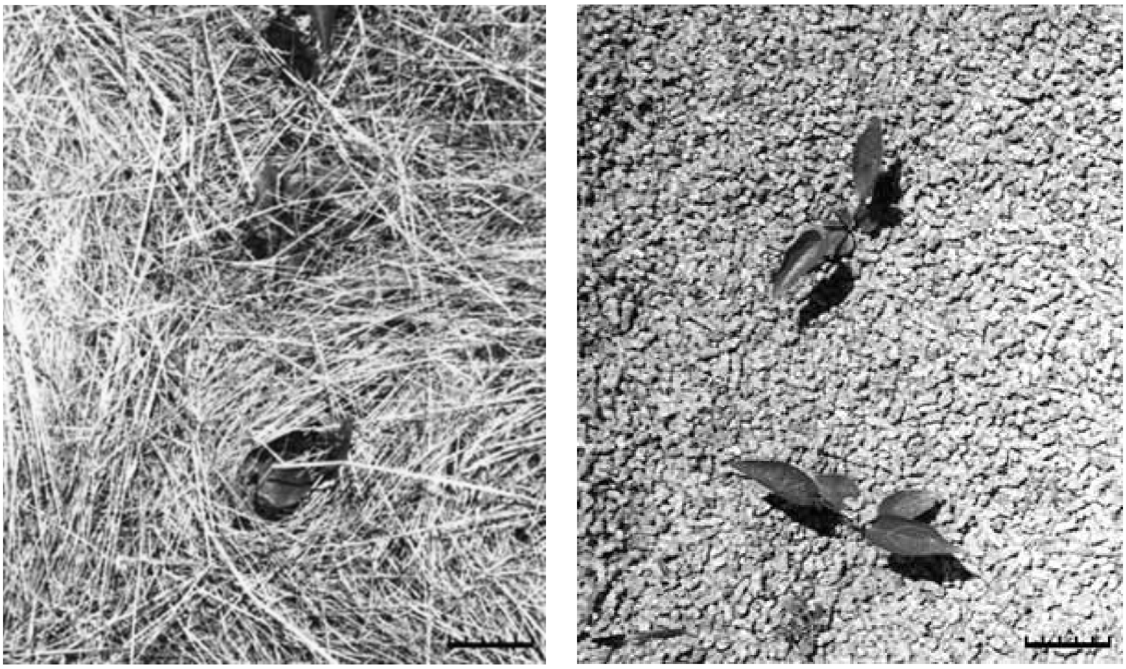


Figure 6.6 Mulch of straw oats 15 cm (right) and granular waste paper (left) (P. Kristiansen, 2007)

Black plastic film mulch effectively blocks emergence of most weeds, including perennials. They also eliminate the light stimulus for weed seed germination. However, these synthetic materials do not enhance soil quality, can interfere with infiltration of rainfall, and (unless a biodegradable material is used) require pickup and disposal at the end of the season. In addition, weeds often come up through planting holes, where they can be especially hard to control. Weed barriers (landscape fabric) last several seasons and can be especially useful for getting perennial crops established. Paper mulches used alone are less effective than plastic, but a paper mulch underneath hay or other organic mulch can enhance weed control over the organic mulch alone.

Clear plastic film mulch raises soil temperature much more than black plastic. During hot summer weather, it can effect *soil solarization*, another form of thermal weed control. Solarization kills emerging weeds, some soilborne crop pathogens and insect pests, and even some weed seeds and vegetative propagules of perennial weeds. However, if conditions are too cool or cloudy to support effective solarization, the clear plastic can simply accelerate weed growth under the plastic layer by creating near-optimum temperatures (M. Schonbeck, 2011)

Mulch can also suppress the small weed seeds in the topsoil due to toxic emissions (allelopathy**)** (M.Liebman and C.L. Mohler, 2001).

Create optimal conditions for cultivated plants. Create optimal conditions for improving the conditions of growth and development of cultivated plants (crop rotation, catch crops, seeding rate, sowing, fertilizing, liming, etc.)

Use of the hexapods eating weeds (phytophagans). This method is especially effective in struggle against such malicious and difficultly eradicated weeds, as Ambrosia artemisiifolia, Acroptylon repens, Sonchus arvensis, Orobanche cumana, Convolvulus arvensis, etc.;

The use of pathogenic organisms and viruses. The use of pathogenic organisms and viruses, you are said to be diseases of weeds.

Use of some fish species. Use of some fish species to control aquatic weeds of vegetable and effectively in the areas of irrigation.

The use of animals and birds. Diversified farming systems that include livestock and/or poultry in addition to vegetables and other annual crops offer expanded weed management options. For example, if a field that has been devoted to annual crop production becomes too weedy, rotating the field into perennial grass–legume pasture or hay for a few years can break the life cycle of the "weeds of cultivation" and reduce their seed banks. Good rotational grazing practices, and/or haying practices can enhance weed control and prevent the buildup of perennial pasture weeds during this period. Many farmers who use such rotations report enhanced productivity as well as reduced weed pressure when the field is returned to vegetable production.

Grazing livestock in fields immediately after vegetable harvest can help curtail weed growth and weed seed production, and running poultry either before or after a vegetable crop can reduce the populations of both weeds and surface weed seeds. The livestock can also be useful in removing diseased crop residues that might otherwise require composting, burning, or deep burial by inversion tillage for disease control.

Livestock can also be used to graze down understory vegetation in orchards, Christmas trees, and other tree plantings (silvopasture), a practice that can accomplish weed management, livestock nutrition, and fertilization (manure) simultaneously.

Weeder geese require water, shade, and fencing for containment and protection from predators while they are working in the fields. They control weeds most effectively during their first year of life, and should be introduced to the fields at the age of six to eight weeks. Older, second-season geese weed much less actively, so it is common practice to utilize the geese for weed control for one season, and then finish them for meat.

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Cattle, horses, and bison are true grazers, strongly preferring grasses, clovers, and other highly palatable legumes. They will eat some forbs (other broadleaf plant species, including some common weeds) that are low in volatile essential oils. Goats are browsers, eating a high percentage of shrubs and forbs, including some with higher levels of volatile oils. Sheep are intermediate between cattle and goats in their grazing habits. Swine not only graze, but will dig into the soil to root out and consume fleshy roots of some perennial weeds.

One limitation of livestock as weed biocontrols is that most animals do not digest all the seeds they consume. As a result, their manure can carry or spread weed seeds from field to field. Thus, they control weeds most effectively when they graze before the weeds set seed (M. Schonbeck, 2010).

Allelopathic Crops. Many crops can act directly as weed biocontrol agents by releasing natural substances that suppress or hinder weed seed germination and early growth, an effect known as **allelopathy**. The substances may be given off by living plant roots, leached from foliage, or released during microbial decay of plant residues. Many cover crops and a few vegetable varieties have been shown to exert significant allelopathic activity against weeds, especially young annual weeds. Well-documented examples include rye, other cereal grains, sorghum, sorghum—sudangrass hybrids, forage radish and other brassicas, and sweet potatoes.

Many allelopathic relationships are quite specific (M. Schonbeck, 2007). For example, sunflower root exudates inhibit seedling growth of wild mustard and other broadleaf weeds, but have little effect on grasses. Sweet potatoes strongly inhibit yellow nutsedge and velvetleaf, but have relatively little effect on pigweed, morning glory, and coffee senna. In no-till field trials, rye residues are strongly allelopathic against pigweed and lambsquarters, but not ragweed.

Recently killed rye mulch is highly suppressive toward lettuce and other small-seeded vegetables, but much less so on large-seeded vegetables like snap beans, and has no adverse effect on transplanted tomatoes, peppers, and cucurbits. Transplants and large seeds are inherently less susceptible to allelopathic suppression. Furthermore, the allelochemicals given off by a cover crop mulch are usually concentrated near the soil surface, while transplants and large seeds are planted deep enough so that their roots escape exposure to the high allelochemical concentrations near the soil surface.

As specific allelopathic relationships become better understood, crop rotations and cropping systems can be designed to give crops an edge over the major weeds present in a given field. The tolerance of transplanted and large-seeded vegetable crops to most allelopathic cover crop residues has practical application in fields whose weed floras are dominated by small-seeded annuals that germinate from near the soil surface. For example, tomatoes and other transplanted summer vegetables often do well in a killed rye–vetch mulch, which usually provides several weeks' effective suppression of summer annual weeds.

Organic Herbicides and Bioherbicides. A limited number of products have been developed that organic growers can spray for weed control. Natural-product herbicides allowed for organic production, including acetic acid (concentrated vinegar), essential oils, and natural allelochemicals, are nonselective contact herbicides most useful for spot treatments of, for example, a localized infestation by a new weed species, or poison ivy on fencerows or near a farm stand. A few bioherbicides based on specific fungal pathogens have been developed against specific weed species that have become especially problematic in particular regions. At this time, however, organic herbicides and bioherbicides play a minor role in the organic weed control toolbox.

6.3 Pest management in organic farming

Insects and other arthropods, such as spiders and mites, are among the most common and diverse organisms in the environment. Over a million different species of insects have been described worldwide, and another 10,000 or so new species are described each year. The vast majority of insects and other arthropods are beneficial or neutral with respect to crop production—fewer than 1% of known insect species are considered to be pests. Insects and other arthropods serve in a number of beneficial ecological roles (sometimes called ecosystem services) in agricultural and natural systems:

- As decomposers, helping to mediate the breakdown of plant and other organic residues, and the mineralization and recycling of plant nutrients from those residues.
- As pollinators, ensuring the fertilization and reproduction of many plants, including many crops.
- As natural enemies (predators and parasitoids), helping to prevent the outbreak of pest insects and weeds.
- As prey, providing food for other organisms, including wildlife and natural enemies of pests.

Some plant-feeding arthropod species only reach damaging levels under particular conditions, while others are well-adapted to tolerate or exploit particular crops or crop production systems, and can regularly cause economic losses. These losses can arise through the direct consumption of plant material such as leaves, fruits, seeds, roots, and sap, or through the transmission of plant disease—for example, the transmission of tomato spotted wilt virus by thrips, and the transmission of bacterial wilt of cucurbits by cucumber beetles. Understanding the ecological principles that underlie the dynamics of insect populations and interactions of populations within communities can help organic producers manage arthropods on their farm, both pest and beneficial species, to prevent or reduce economic crop losses (M.E. Barbercheck, 2010).

Pests are generally not a significant problem in organic systems, since healthy plants living in good soil with balanced nutrition are better able to resist pest attack. However, major pest damage is sometimes seen in organic crops, particularly in vegetables such as carrots and brassicas, which are very susceptible to damage from root flies. Pest problems can be particularly severe in large horticultural holdings, where several hectares of a single crop species may be grown. Pest control strategies in organic farming systems are mainly preventative rather than curative. The balance and management of cropped and uncropped areas, crop species and variety choice and the temporal and spatial pattern of the crop rotations used all aim to maintain a diverse population of beneficial organisms including competitors, parasites and predators of pests. Damaging populations of pests and pathogens are less likely to establish in soils that sustain high levels of beneficial organisms (A.M. Litterick et al, 2002).

Break crop choice and rotation design can have a major impact on the incidence and severity of certain types of pest problems. The less mobile pests or those which have a specific or narrow host range are particularly susceptible to crop rotation. Highly mobile, often non-specific pests such as aphids are less affected, or unaffected by rotation design. Reactive treatments for pest outbreaks, including natural pesticides, are permitted under regulations for specific situations in organic systems, but cultural pest pre-vention techniques including the use of break crops within balanced rotations will remain the most important means for pest control in organic systems.

To control the number of insects in organic farming shall enjoy the fol-lowing methods:

The choice of varieties.

Plant breeders traditionally have placed more focus on creating disease-resistant varieties than on creating insect-resistant varieties. Where they are available, however, insectresistant varieties can be an effective defense. It is important to find out about the mechanism of insect resistance in a crop variety because genetically modified crops (GMOs, transgenic crops) are not allowed in organic production systems. Even when insect-resistant cultivars are not available, some varieties may be less attractive to pest species or tolerate more damage than others. Plant size, shape, coloration, leaf hairs, and natural chemicals—both attractants and repellents—all affect the outcome of insect crop colonization. Note that changing cultivars to reduce pests can also reduce beneficial insects either directly (characteristics that affect pest abundance may also influence beneficial insects) or indirectly (through providing less prey).

Crop Rotation and Isolation

Crop rotation and crop isolation strategies are most effective against pests that do not disperse over great distances and/or that overwinter in or near host crop fields. Examples include the Carrot Rust Fly, Colorado Potato Beetle, and Onion Maggot. In contrast, crop isolation/rotation is much less effective for pests such as the Cabbage Maggot that can move great distances.

As indicated above, insect pests with limited mobility, pests that overwinter or feed below ground (like corn rootworm), or pests with one generation a year may be substantially suppressed by rotating or moving the crop to a different location. However, the distances required may be more than small-scale growers can manage. For example, one study demonstrated that potatoes had to be moved about one-quarter to one-half mile from the previous season location in order to significantly reduce infestation by Colorado Potato Beetle. Successful organic growers usually practice a 5-7 year crop rotation plan, which is also effective for management of soil diseases.

Time of crop planting and harvesting.

Phase of growth and development of cultivated plants may have a significant impact on their attractiveness to insects. Thrips, for example, often infest early-planted crops in high numbers but are less of a problem on later planted crops. For some insects, planting a crop early and getting ahead of the problem (crop gets to a less or non-susceptible physiological stage) can be a practical solution to management. For example, corn earworm on sweet corn is less of a problem in early-planted crops. On the other hand, squash bugs tend to be less of a problem if planting can be delayed until the over-wintering bugs have died off. Farmers can experiment with different planting dates and then adjust planting schedules accordingly to avoid peak pressure (balancing with market demands for availability of that crop).

Vigorous crop growth is also important. Seeds should be sown when temperatures will allow them to emerge and grow quickly. Using seedlings or transplants instead of seeds can also speed crop development. Plants struggling to survive or plants under stress will be more attractive to pest insects and more affected by damage.

The shorter the time a crop is in the field, the less time pest insects have to damage it. Combining early planting with early maturing varieties may allow a crop to mature before pest insects reach damaging levels.

Density planting and seed rate.

Decisions about crop population densities are dictated more by the growing characeristics of the crop, weed management, and harvest requirements than by pest insect management. In general, if increasing the population density of a crop increases beneficial insects, it can lead to a decrease in pest insects. In some crops, close row spacing increases control by beneficial insects. More ground shading will usually increase grounddwelling predators, such as ground beetles. Some species of ground beetles also consume weed seeds on the soil surface.

Management of soil fertility.

Proponents of organic farming have long promoted the view that the likelihood of pest outbreaks is reduced with organic farming practices, including establishment and maintenance of "healthy" soil. Recent studies have shown that plant resistance to insect and disease pests is linked to optimal physical, chemical, and - perhaps most importantly - biological properties of soil (G. Zehnder et al., 2007).

Proper nutrient management is an important component of IPM in organic systems.

Although crop plants must grow vigorously to withstand pest damage, overly lush plants often attract more pest insects and experience more damage than other plants. Overfertilized plants may give visual clues to insects and become targets of attack. Survival of immature insects may also be better on overfertilized plants. Nutrient stress from insufficient plant nutrients can also cause plants to be more attractive to insect pests or more susceptible to damage by insect pests. Consequently, the careful planning and execution of soil fertility programs (including pH) is an important component of pest insect management.

Regulation of water regime of soil.

Irrigation has both direct and indirect effects on pest insects. Insect populations can decrease if overhead sprinklers knock insects off plants or raise microenvironment humidity enough to encourage insect disease caused by bacteria or fungi. Because irrigation methods vary considerably (whether drip, overhead sprinkler, or flood irrigation), the impact of irrigation on insects also varies. Pest insect populations can increase if irrigated plants are lusher and more attractive than surrounding plants. Likewise, plants stressed by drought can be more attractive to insect pests or less tolerant to their feeding. The need for irrigation is dictated by crop growth and weather rather than the need for insect control. But when there is some flexibility in irrigation scheduling, a farmer should think about irrigation as a tool for suppressing pest insects. Several naturally occurring insect pathogens, especially insect-pathogenic fungi, provide effective pest suppression when high humidity microenvironments are created.

Tillage.

Tillage practices affect both subterranean and foliar insect pests. Infrequent disturbance of soils in natural systems preserves food webs and diversity of organisms and habitats. The regular disturbance of agricultural soils disrupts ecological linkages and allows adapted pest species to increase without the dampening effects of natural controls. Nevertheless, tillage can also destroy insects overwintering in the soil as eggs, pupae, or adults, and reduce pest problems.

Organic producers usually rely on tillage to control weeds and to prepare the soil for planting. Research is being conducted on methods and equipment that may allow for the reduction of tillage in organic systems. Some practices to reduce tillage in organic systems include zone tillage, ridge tillage, and including a perennial or sod-producing crop in the rotation. Reduction of tillage alters pest insect dynamics considerably. Thrips cause fewer problems in reduced-till systems. Ground-dwelling predators, such as ground beetles that prey on pest insects, can increase. However, cutworm and slug problems can also increase where tillage is reduced. The degree of pest population shifts between a tilled and reduced-tillage system cannot be reliably predicted. Species shifts will occur and should be carefully monitored. Tillage is not likely to have a significant effect on most common foliar-feeding insect pests.

Mulches.

Mulching systems fall into various categories, including plastic (woven or nonwoven) and natural materials. Although allowable, the use of plastic mulch is frequently discouraged by organic certification agencies because it relies on a nonrenewable resource. Biodegradeable plastic mulches are being developed and may affect pests in a similar way to that of conventional, nonbiodegradeable muclhes. Organic farmers often use a straw mulch because it is readily available and provides good weed suppression. Planting into a living or killed mulch is growing in popul New systems, such as hydromulch (which consists of wood fibers sprayed on with an adhesive to keep them together) may one day supplant plastic and straw if they are developed with organically allowable components. For now, plastic and straw mulches remain high in popularity.

All mulches suppress insects in comparison to bare soil. Different colors of plastic have been tested; and clear, white, yellow, or aluminum (reflective) colors may provide some additional suppression of aphids and whiteflies. Blue and yellow may bring in more pests. Plastic can be painted the desired color. Before painting mulch, farmers should check with their certifiers to see if the practice is allowable.

Straw mulches can affect insect pests. Crops that are traditionally mulched with plastic may benefit from straw mulches. For example, suppression of the Colorado potato beetle has been demonstrated with straw mulch in potatoes. Not enough information is available to make definite recommendations about the advantages of one mulch over another. Testing in a restricted area is recommended when using mulches for the first time or changing mulching materials. Mulching alone will probably not prevent pest problems. Nevertheless, if used in combination with other tactics, mulching may help reduce populations of difficult insect pests.

Sanitation.

Good farm sanitation can help to prevent introductions of pest insects from outside sources, slow their movement within the farm, and eliminate them when they are discarded with crop materials that may harbor them.

If transplants are purchased off-farm, buy from a reputable dealer and check very carefully before bringing transplants to the farm. A simple screening process can save time and money later. Quarantine any purchased transplants for at least a week, and examine them carefully for pests daily.

Culled plants and produce are often piled near the field or processing area for later disposal. This can provide a suitable feeding and breeding site for insect pests. These piles should be composted, buried, or otherwise destroyed as soon as possible.

Companion Planting.

The companion planting approach is based on the theory that various plants grown in close proximity to the crop plant will repel or kill pest insects. Studies to date have not shown this approach to be effective. Note that companion planting is not the same as intercropping, which may be a valuable tool in attracting beneficial insects.

Trap Crops.

Trap crops attract pest species away from the cash crop to be protected and into a specific area where they can be destroyed. Depending on the target pest and the cash crop, trap crops can be planted with or around the perimeter of the cash crop field. This approach is an appealing idea, and it has proven useful in some situations. Implementation of trap cropping takes careful management. Knowledge of the biology and ecology of the target pest species is critical when considering trap cropping. Species that are weak fliers or pests that are blown into a crop (such as aphids) or are dispersed in the wind (such as spider mites) are not good candidates. Good target pests show a strong preference for a particular type, variety, or physiological stage of the crop.

For example, scientists Krasnoobsk (Novosibirsk region) as a Trap crops are used mustard white that blooms earlier (due to earlier sowing times) than the main crops - canola. When in traps pests them are going destroy.

The use of pheromones.

Insects are very small creatures in a very large world. They have evolved many different ways of finding each other to mate. Some insects can make a sound as loud as a chainsaw; others have striking colors. Many insects find each other over long distances by emitting chemical signals or pheromones to attract individuals of the same species into an area so they can find each other to mate. Once the individuals get close together, visual cues-such as color, shape, and behavior - become more important. Entomologists have determined the chemical structure of pheromones for many pest species and duplicated them synthetically.

Pheromones and other chemical attractants can be used in several different ways: to monitor pests, disrupt mating, capture a large number of adults (called mass trapping), distribute an insect pathogen or or lure pests to consume poisoned bait. Any trap baited with an attractant must be used carefully. Some research has demonstrated that a trap can bring more pests into an agroecosystem than it kills.

Biological control is the use of living organisms to maintain pest populations below damaging levels. Natural enemies of arthropods fall into three major categories: predators, parasitoids, and pathogens (M. Altieri et al., 2005).

Predators.

Predators catch and eat their prey. Some common predatory arthropods include ladybird beetles, carabid (ground) beetles, staphylinid (rove) beetles, syrphid (hover) flies, lacewings, minute pirate bugs, nabid bugs, big-eyed bugs, and spiders.

Parasitoids.

Parasitoids (sometimes called parasites) do not usually eat their hosts directly. Adult parasitoids lay their eggs in, on, or near their host insect. When the eggs hatch, the immature parasitoids use the host as food. Many parasitoids are very small wasps and are not easily noticed. Tachinid flies are another group of parasitoids. They look like large houseflies and deposit their white, oval eggs on the backs of caterpillars and other pests. The eggs hatch, enter the host, and kill it. Parasitoids often require a source of food in addition to their host insect, such as nectar or pollen.

Pathogens.

Pathogens are disease-causing organisms. Just as many other organisms get sick, so do insects. The main groups of insect disease-causing organisms are insect-parasitic bacteria, fungi, protozoa, viruses, and nematodes. Biological control using pathogens is often called microbial control. One very well-known microbial control agent that is available commercially is the bacterium Bacillus thuringiensis (Bt). Because not all formulations of Bt are approved for use in organic systems, it is important to check with your certifier before using this. Several insect-pathogenic fungi are used as microbial control agents, including Beauveria, Metarhizium, and Paecilomyces. These are most often used against foliar insect pests in greenhouses or other locations where humidity is relatively high. Nuclear polyhedrosis (NPV) and granulosis (GV) viruses are available to control some caterpillar pests. The insect-parasitic (entomopathogenic or insecticidal) nematodes, Steinernema and Heterorhabditis, infect soil-dwelling insects and occur naturally or can be purchased. As with all biological control agents, it is especially important to match the correct microbial control agent with the correct pest in order for them to be effective.

6.4 Disease control in organic farming

Crop diseases are a serious problem both in traditional as well as in organic agriculture. Manage the disease rather difficult for several reasons. First of all pathogens is difficult to identify because they are very small and often require special equipment and training, that complicates exact diagnosis in field conditions. Second, pathogens are constantly changing, mutating, making it difficult to deal with them already known means and methods, and requires the introduction or development of new methods. Third, plant diseases are caused by a wide range of fungi, bacteria, viruses and nematodes.

These reasons are becoming more relevant in organic farming, as application of plant protection chemicals is limited. In addition, to organic farms and received production increased requirements. You need to know when and how the contamination of crops.

Disease on crops will only occur when something that can cause disease, meets a plant that can get the disease, and under the right conditions. This may sound trivial, but keeping these three cornerstones of disease in mind–more technically described as the confluence of a virulent pathogen, a susceptible host, and a conducive environment is the key to rational control for an organic farmer. Visually, this can be represented as «disease triangle» (L.J. Francl, 2001).

Avoid the virulent pathogen, for example through the use of disease-free seed. Eliminate the susceptible host, by using a resistant cultivar or a smart rotation. Make the environment unfavorable, say with well-drained raised beds or plant spacing that improves air circulation. And as an organic farmer, keeping the whole system in mind, one must use the idea of confluence of these three factors to one's advantage.

Actually, in some circumstances not all three elements of the disease triangle are in fact necessary for disease to occur. Environmental conditions can sometimes combine with the host plant to create a disease in the absence of a biological pathogen. For instance, injury due to cold, or fruit scorch in high sunlight, or growth stunting because of pollution are all types of diseases with no causal organism. These disorders are called «abiotic» (M. Boudreau, 2011).

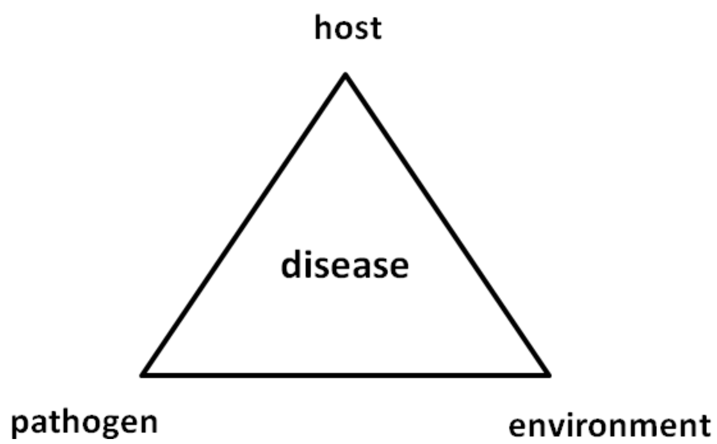

Figure 6.7 The combination of conditions that determine the appearance and development of diseases in crop plants (L.J. Francl, 2001)

In organic farming using disease management strategy based on an ecological approach. For example, as far as possible organic system must support the growth and diversity of soil and epiphytic micro-organisms that are natural antagonists of pathogenic microorganisms and help to increase the genetic diversity of crops in the rotation.

To do this, use the following methods, which are similar to the methods of combating weeds and pests (Figure 6.8).

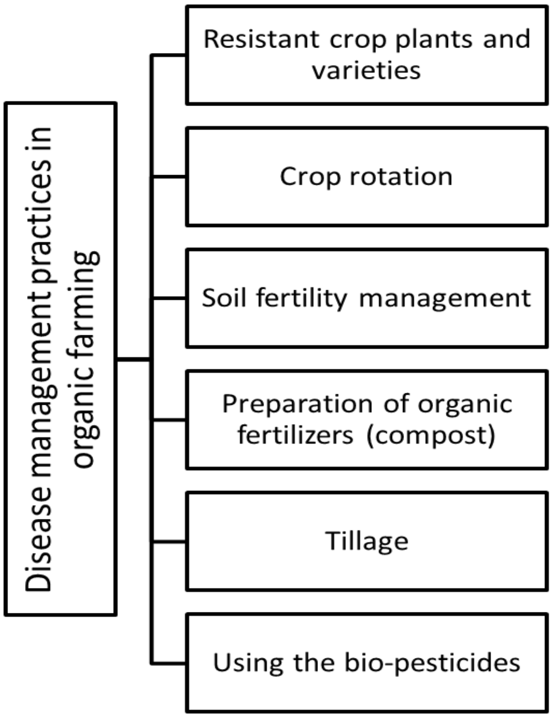

Figure 6.8 Disease management practices in organic agriculture

Levels of soil borne pathogens and root disease are generally lower in organic systems than in conventional. Airborne pathogens do not generally cause serious problems in organic systems, but there are a few exceptions such as potato late blight and powdery/ downy mildews in vegetable and fruit crops.

The less mobile, soil-borne diseases such as rhizoctonia root rot and stem canker of potatoes and clubroot of brassicas can usually be adequately controlled through the use of balanced rotations, appropriate break crops and good soil husbandry. Not all soil borne pathogens are controlled adequately through crop rotation, for example, it is often difficult to control root-inhabiting pathogens that survive saprophytically in soil organic matter and exist for long periods in the absence of a host plant. These pathogens include *Pythium* spp., some *Fusarium* and *Phytophthora* spp. and *Sclerotium rolfsii*. Highly mobile, airborne pathogens are generally not controlled through crop rot tion. In these cases, resistant species and varieties and cultural controls are used to minimise disease incidence and severity, for example, variety mixtures and intercropping are useful aids to foliar disease control.

Direct disease control methods are rarely necessary in most organic crops, although some natural and plant extract-based fungicides are applied regularly to control foliar disease in some high value crops such as top fruit, grapes and vegetable transplants. Biological control of fungal diseases is permissible in organic systems, but few products are available because of difficulties in registration and the lack of cost-effective mass production (A.M. Litterick, 2002).

7 Organic plant breeding and seed production with regard to ecological and ethical aspects

7.1 Features of crop varieties that are used in of organic agriculture

Organic agriculture is increasingly gaining social, political and scientific recognition for its contribution to sustainable agriculture.

Organic farmers have long depended on conventional variety and seed production, and have accepted it until other aspects of organic farming got established first. (E.T. Lammerts van Bueren et al, 2007). Organic farmers profit from the improvements of conventional breeding, but this does not imply that those are the best varieties for use in organic farming systems. Varieties supplied by conventional seed companies are developed for farming systems in which high levels of artificial fertilisers and agro-chemicals are applied. Organic farming, however, aims at a low input system and at refraining from agro-chemical inputs. To be able to avoid those kind of inputs, development and application of agro-ecological strategies are necessary. This has resulted in a fundamentally different farming system compared to the conventional one, especially with regard to soil fertility and disease and pest management. Therefore, organic farmers require (new) varieties with characteristics that are better adapted to this kind of farming to be able to further optimise the organic farming system.

The organic farming system differs fundamentally in soil fertility manage-ment, weed, disease and pest management, and has higher demands on product quality and yield stability compared with conventional farming. Organic farming systems aim at resilience and buffering capacity in the farm-ecosystem, by stimulating internal self-regulation through functional agrobiodiversity in and above the soil, instead of external regulation through chemical protectants. At the same time organic systems of agriculture have less than possibilities for the fast decision of arising problems. This explains why, for further optimization of the principle of self-regulation systems, organic farming requires new varieties possessing characteristics that make them flexible, appropriate buffer capacity.

Organic farmers do not require varieties with a higher yielding capacity in the first place because of the risk of losing such profit by (increased) disease susceptibility, but require varieties that show a higher yield stability through improved adaptation to organic farming systems and by that less yield reduction. Varieties are required that have higher yield stability by increasing adaptability to organic farming systems that cause less yield loss. These new varieties will surpass the best traditional varieties currently used in organic agriculture. Until now this direction, by and large, paid little or no personal attention in traditional breeding, whereas in organic farming systems, they are important.

In the short run designing ideotypes with a participatory approach among farmers, breeders

> ***Ideotype.***
>
> *Donald (1968) proposed the ideotype approach to plant breeding in contrast to the empirical breeding approach of defect elimination and selection for yield per se. He defined «crop ideotype» as an idealized plant type with a specific combination of characteristics favorable for photosynthesis, growth, and grain production based on knowledge of plant and crop physiology and morphology. He argued that it would be more efficient to define a plant type that was theoretically efficient and then breed for this.*

and traders can contribute to a more adequate selection of varieties suitable for organic farming systems from among the existing assortment of «conventional» varieties. For the future our conclusion is that breeding programmes for new «organic» varieties based on the proposed organic crop ideotype may benefit not only organic farming systems, but will also benefit conventional systems moving away from high inputs of nutrients and chemical pesticides.

The way organic farmers assess varieties shows that they focus on a diversity of agro-ecological aspects resulting in an organic crop ideotype with several additional plant architectural and growth dynamical properties that can directly and indirectly contribute to yield stability and reduce the risks of quality and yield loss. For leafy vegetables, for example,it is important that they have the ability to grow in early spring conditions when the soiltemperature is low and so is the mineralisation of organic nutrients. More attention needs tobe paid to the development of a better root geometry (deeper and finer rooting system), for more efficient water and nutrient uptake and the ability to maintain steady plant growth without stress under fluctuating water and nutrient availability.

Examples of different crops and the variety demands of organic farmers compared with the chemical solutions in conventional agriculture, are given in Table 7.1. The general variety characteristics as discussed before on the basis of the agro-ecological approach to enhance the self-regulatory ability for the main components of organic farming strategies, are summarised in Table 7.2.

Table 7.1 Requirements for variety in organic farming and conventional (chemical) methods of solving problems

Crop	**Variety characteristics required by organic farmers**	**Chemical solutions available for conventional farmers**
Apple, pear	Ability to take up calcium Little biennial bearing Fruit set also under cold weather conditions	$CaNO_3$ leaf sprays (apple) Flower pruning agents Gibberellic acid for parthenocarpy (pear)
Cereals	Long straw and peduncle Less compact ear against ear diseases.	Fungicides
Cereals, carrot, cabbage, etc.	Rapid juvenile growth to cover the soil	Herbicides
Potato	Hairy and tougher leaves against aphids	Insecticides
Potato, onion	Long-term storability without sprouting	Chemical sprouting inhibitors
Onion, cabbage	Leaves with a wax layer for tolerance against fungal diseases	Fungicides

Source: T. Lammerts van Bueren, 2002

The consequences of losses due to pests and diseases in organic farming systems differ considerably, depending on region, crop, farm structure or market demands. In general, yields in organic agriculture are 20% lower due to a lower nitrogen-input (up to 50% less nitrogen) and in some cases due to pests and diseases (P. Mäder et al. 2002). Further optimization of the organic production can be supported if the yield stability is raised through a better control of diseases and pests.

Table 7.2 General criteria for desired variety characteristics for organic farming systems derived from the agroecological approach

Variety characteristics	Criteria
Adaptation to organic soil fertility management	Adaptation to low(er) and organic inputs; ability to cope with fluctuating N-dynamics (growth stability); efficient in capturing water and nutrients; deep, intensive root architecture; ability to interact with beneficial soil microorganisms, like mycorrhizae, atmospheric nitrogen-fixing bacteria; efficient nutrient uptake, high nutrient use efficiency.
Weed suppressiveness	Plant architecture for early soil cover and more light-competition, allelochemical ability; allowing and resisting mechanical/physical control.
Crop health	Monofactorial and polyfactorial, durable resistance; field tolerance; plant morphology; combining ability for crop or variety mixtures; capable of interaction with beneficial microorganisms that enhance plant growth and suppress disease susceptibility.
Seed health	Resistance/tolerance against diseases during seed production, including seed-borne diseases; high germination percentage; high germination rate; high seedling vigour.
Crop quality	Early ripening; high processing/baking quality; good taste; high storage potential.
Yield and yield stability	Maximum yield level and yield stability under low-input conditions.

Source: T. Lammerts van Bueren, 2002

From comparative studies between conventional and organic (reduced-input systems) is concluded that in organic or reduced-input farms root diseases and pests are generally less of a problem than foliar diseases, because foliar disease development is much more determined by climatic factors. (E.T. Lammerts van Bueren, 2002). Many root diseases can be eliminated by the broad rotation in organic systems. For most air-borne diseases a good crop management which avoids stress will improve the tolerance of a crop. Therefore, an essential element in organic farming systems is to gain and maintain soil fertility with an active soil life contributing to the nutrient availability, good soil structure and crop specific manuring for buffering and resistance to unbalanced plant growth. The organic sector lacks a large availability of ‘natural’ sprays.

Since an organic grower has hardly any curative and quick corrections available he, in contrast to his conventional colleague, will have to give more priority to varietal disease resistance, even if this is associated with a lower productivity. Because in many cases, organic growers can keep the disease pressure low with ample rotation and low nitrogen input, the focus is not merely on varieties with an absolute disease resistance; in many cases field resistance can be sufficient. This will be difficult to achieve on leafy vegetables when the whole product is to be harvested and sold. However, in case of Bremia, for example, it is worthwhile researching the possibilities of selecting for those types of lettuce that allow this fungus at a stage where it will only infect the older, outer leaves that are not to be harvested.

It should be noted that in Russia there is a wide variety of agro-climatic zones with different adverse environmental factors (often contradictory). In addition, a significant part of territories applies to zones of risky agriculture with sharp fluctuations in weather conditions. In such circumstances, it is essential to create varieties adapted to specific conditions. For example, when creating a winter wheat varieties for the southern regions of the country pay special attention to resistance to rot, snow mold, and the zone of the Volga and Western Siberia, winter-hardy varieties are needed that can withstand freezing soil and winter drought. For regions with high precipitation are needed not lodging varieties, and for the steppe areas - drought-resistant, etc.

For organic farming it is desirable to use varieties that can generate yield, with moderate nutrient content in soil. One approach to solving this problem is to create plants that have the bulk of the stored substances sent to the productive organs, and smaller remains in vegetative mass. Examples of success of selectors in the given direction are building of high-yielding varieties of wheat of nanous phylum, dwarfish forms of apples, varieties of a sugar beet with large root crops and the reduced leaves. During the period of perestroika in Russia, where farms were not able to because of economic difficulties to apply intensive technologies, the need arose in the varieties of this type. A number of breeding facilities have been implemented breeding programs to create varieties that can generate yield at a low level of plant nutrition.

In general, the efforts of breeders lead to a gradual increase adaptability, yield, and plant resistance. These results should be used wisely in technologies for organic farming.

Certain role in increase of adaptability of plants and improvement of ecological conditions in agrocenosis, productivity growth, can play and seed production.

7.2 Seed production in organic agriculture

Organic seed production is still largely a missing link in the organic food production chain. Although judging by the information of Internet sites devoted to the promotion of organic seeds, has recently seen a significant increase in interest in this question (K.L. Adam, 2005). For example, the U.S. Department of Agriculture provides funding for workshops on organic seed producers, small seed companies and universities.

According to EU regulations 2092/91 for organic agriculture, organic farmers shall use organically produced seed and planting material.

Problems and challenges associated with organic seed production can be categorised into:

- market aspects,
- technical aspects,
- aspects relating to quality standards.

For successful production of organic seed and planting material, intensive communication between and mutual commitment of farmers, traders, breeders and governmental organisations are necessary. Farmers together with traders should be involved in variety testing and designing of crop ideotypes to identify the desired variety traits. Breeders can influence further improvement of organic production not only by organically propagating the best suitable, existing varieties, but also by integrating organic traits in future breeding programmes. Furthermore, a great effort is needed to carry out comprehensive and coherent activities related to the development of empirical knowledge and research-based information on adapting and improving cultural practice for organic seed production, developing resistant varieties for healthy seed production, developing protocols for seed health testing, assessing threshold values, and designing organic seed treatments.

Typically, there are two questions related to organic seed production:

1. which varieties should be propagated; and
2. how should it be done?

The first question is largely answered in the former paragraph (7.1), the second one will be addressed by discussing diversity, technical aspects and seed quality standards.

Diversity of varieties

In Europe and the USA, regulations no longer allow derogation for the use of conventionally propagated seeds of crops for which a sufficient assortment of organically propagated varieties and seed already available. As this seed assortment usually consists of a minimum number of varieties, it has immediate consequences for the diversity of varieties that can be used ill the organic sector and creates tension between short and long term goals in the organic sector. There is the need not only to close the organic food supply chain as soon as possible to increase accountability for consumer but also to have a diversity of varieties to meet the requirements of different market sectors and farming conditions.

There are roughly two groups of farmers involved in this difficult area. The first is those small-scale farmers who focus on the local market with the use of local and old varieties, the so-called conservation or heritage varieties. Often, such farmers care for a community-based and participatory seed production and exchange system to conserve the local varieties or maintain old varieties that are suitable for low-input conditions. These farmers are threatened by restrictions from the new regulations because many of those conservation or local varieties are not officially registered and/or not propagated organically. When they want to save their own seeds from modern varieties they have to deal with restrictive regulations on farmers' rights for saving their own seed.

The second group is large-scale farmers who produce for supermarkets and have to meet specific quality and uniformity requirements. These farmers depend largely on modern, hybrid varieties of commercial seed companies and on the breeding policy of such companies. For economic reasons, not all companies are willing to enter the relatively small, organic market and produce all the desired varieties organically. Those who do take part in organic seed production produce only a limited assortment, which constrains the choice compared with the larger assortment of conventionally propagated varieties.

Technical aspects

As organic farming systems refrain from the use of chemical protectants, it is even more important that seed and planting material is of high quality as they form the basis of crop production. The development of high quality propagating material requires the development of specific expertise on aspects of seed production including technical knowledge, choice of location and varieties.

The main problems in organic seed production are: nutrient management, disease and pest management, and weed control. Among the seedborne diseases in particular require special attention. To reduce the risk of disease infestation, optimal climatic conditions and thus the location for seed production can be important. In some cases seed production should be located in warmer and drier climates, away from the areas of origin and destination.

However, optimizing organic seed production not only requires adapting cultural practices as mentioned above, but also that specific attention needs to be paid for variety traits during seed production. This applies especially to biennial vegetable crops, which can build up disease pressure in the first year and then suffer from a continued increase of disease pressure during seed formation in the following year. Another aspect that influences the success of organic seed production is that some parental lines of hybrids have reduced growth vigour and, therefore, are susceptible to biotic stresses including diseases. This implies that growth vigour as a variety characteristic is even more important in organic seed production than in conventional seed production.

Seed quality standards

Organic seed production without chemical inputs is a challenge for seed producers. The usual criteria for conventional seed quality also apply to organic seed: physical and genetic purity, absence of weed seeds, and a minimal requirement for germination. In some cases it is not always possible to produce seeds without a certain degree of contamination with diseases. Several methods can be applied to improve the seed quality. One method is grading and separating infected seeds from healthy seeds by selecting based on seed weight or size, as known in the case *of Fusarium* on cereal seeds. For some seedborne diseases additional postharvest, non- chemical treatments are needed, such as hot water or hot air treatments (Forsberg *et al* 2000). However, more research is needed to optimise such methods to reduce the risk of damaging the seed (Jahn *etal* 2004). Next to these physical treatments, disinfecting coatings with natural compounds are being developed, such as organic acids (mustard powder) or essential oils (thyme oil). In seed potato there are positive results with treatments against Rhizoctonia solani with the antagonist Verticillium biguttatum.

For some crops there is no problem in meeting the quality standards as required for conventional seeds, but in some cases the thresholds for seedborne diseases are adjusted. In some countries the recommended tolerances or thresholds for some diseases are lowered. In Austria, for instance, the threshold for Fusarium nivale has been adjusted from 20% in conventional agriculture to 10% for the organic sector. In the Netherlands, the level of permitted contamination in organic seed potato has been lowered from 25% (conventional) to 10%. A lower threshold is also set in other diseases, for example, in Austria, 10% is permitted for Septoria nodorum in cereals, compared with 20% previously.

7.3 Genetic modification, in vitro – ecological and ethical questions

In ethical discussions about the application of modern biotechnology techniques, it is genetic engineering that attracts the most attention. A distinction is made between extrinsic arguments, dealing with the consequences of making genetically modified organisms (GMOs), and intrinsic arguments about the technology itself. There is in general much discussion about the meaning and validity of the intrinsic arguments, which are also dominant in the rejection of GMOs by the organic sector.

The first genetically modified (GM) foods (tomatoes with delayed ripening) appeared on the U.S. market in the mid-90's. At the moment there are GM varieties of corn, soybeans, oilseed rape and cotton are actively cultivated in several countries, and received at the same time products are delivered to the international market. In addition, GM varieties of papaya, potato, rice, pumpkins and sugar beets have already appeared on the market or are in various stages of testing. According to expert estimates, the global GM crops are grown by about 4% of all cropland in the world.

Interestingly, the European regulation on GMOs is based on both process and product. This means that oil derived from genetically modified soybeans is considered a GMO even though it contains no modified DNA (only protein contains modified DNA). This is in contrast to the USA where the regulation is purely product based, and the oil is not considered as a GMO.

Conflicting results of the evaluations and far from exhaustive study benefits, risks and limitations of the use of GM foods heated ongoing debate. During hunger in Southern Africa in 2002 the unwillingness of some countries to accept as a part of the humanitarian help GM products, first of all, has been bound not to questions of health of the person and ecology, and with social and economic, ethical problems and property questions. Such contradictions have revealed not only existence of a wide spectrum of the opinions occurring in member states of the United Nations on intra- and interstate levels, but also heterogeneity of standard bases and principles of an assessment of advantages and the risks bound to GM food stuffs.

In ethical committees and public debates the emphasis is on the so-called extrinsic concerns: the risks for human health, for animals and for the environment. Most methods of risk analysis look only at the consequences and the effects of genetic engineering within the framework of a utilitarian ethics (weighing costs and benefits). Organic agriculture and, consequently, its norms and standards are focused on production methods, rather than the final product. The farmer, for example, to pass certification, because his farm is managed in accordance with the standards, not because its products have a certain level of quality (E.T. Lammerts van Bueren, 2010).

This difference between product and processbased focus causes confusion in the public discussion of GMOs. In a discussion people may speak from different standpoints, focussing either on the product or the process of genetic engineering.

Why organic agriculture rejects the use of GMOs

The International Federation of Organic Agriculture Movements (IFOAM) is opposed to genetic engineering in agriculture in view of the unprecedented danger it represents for the entire biosphere and the particular economic and environmental risks it poses for organic producers. The reasons mentioned by IFOAM can be clustered into three groups (E.T. Lammerts van Bueren, 2010):

1. Risks for human health and the environment

- negative and irreversible environmental impacts
- release of organisms that have never before existed in nature and which cannot be recalled
- pollution of off-farm organisms
- unacceptable threats to human health.

2. Socioethical reasons

- pollution of the gene pool of cultivated crops, microorganisms and animals
- denial of free choices, both for farmers and consumers
- violation of farmers' fundamental property rights and endangerment of their economic independence.

3. Incompatibility with the principles of sustainable agriculture.

The rejection of GMOs in organic agriculture is based more on a different perception of risks than upon the presence or absence of scientific proof that risks exist objectively. The perception of risk from an organic perspective is based on a holistic view of life.

Our conclusion is that intrinsic arguments against genetic engineering are widely used in the field of organic agriculture. Such arguments usually rest upon a specific view of the human- nature relationship, which includes cognitive, emotive and volitional elements. Cognitive elements refer to a holistic (non-reductionist) view of living organisms. Emotive elements refer to a biocentric attitude towards life in which living organisms are seen as partners that should be respected, with an intrinsic value. The volitional elements refer to ethical statements as to what should or should not be done in organic agriculture, taking other elements into account.

Respecting the integrity of plants can also have consequences for the application of other modern breeding and propagation techniques for organic breeding and propagation programs. It may imply:

- reproductive barriers between species will be respected and not violated;
- in vitro techniques are not compatible with organic principles;
- sterility, such as cytoplasmic male sterility, will not be accepted in the end product (variety) without including restorer genes; and
- patents on life are not accepted.

8 Organic livestock husbandry and breeding

8.1 The role of livestock in organic agriculture

Animals have been important in organic farming systems from the outset, both conceptually and in practice, and high animal health and welfare status of the animals has always been an important goal for organic husbandry. Animals should be an integral component of the organic farm, part of a system in which all parts interact to their mutual benefit, and where a harmony is created between the land, the animals and the people. The farm strives to be a closed system, producing feed for its own animals and incorporating their manure into crop production.

Nevertheless, as opposed to the crops, animals are not just parts of this system; they are also sentient creatures and as such they deserve special moral considerations. This makes their management fundamentally different from that of crops. When a farmer is learning to manage a farm with no chemical inputs, sometimes afield may become overgrown with weeds, for example. The farmer might not be able to do much about it, and may simply accept the loss as an inevitable part of learning how to farm organically.

However, it is not acceptable to let animals suffer or die. This moral aspect of dealing with sentient beings gives animals a special status on the farm. They are individuals that need to be looked after, that can suffer, and that can interact with each other and with the humans around them. Animal welfare – the notion that animals have experiences and are sentient beings – gives humans a moral obligation to treat animals well and to intervene before they suffer or die. This obligation allows us to use synthetic medicines for treating sick animals – the only circumstance where use of «chemicals» is allowed and recommended in organic farming in some cases and by some people to avoid suffering (M. Vaarst and et al., 2004).

Whilst the avoidance of suffering is important in both organic and conventional animal husbandry, the organic farming principles go much further than that in pursuit of animal welfare. One of the basic principles of organic farming refers to access to natural behaviour for organically managed animals, which substantially broadens the concept of ‘welfare’. Moreover, this heightened understanding of the lives of animals needs to be put into practice. Because of the wide range of production systems and growing conditions throughout Europe, this is a very difficult task that presents many exciting challenges. (V. Lund, 2006).

Discussion is needed not only of how organic farming influences the lives of the animals, but also of how our awareness of animals and their welfare can influence the development of organic farming. The special situation of animals – as both sentient individuals and parts of a farming system – raises interesting questions. Because ‘individuals’ must be handled differently from ‘parts of the farm’, the animal herd in some cases seems rather disconnected from the organic farm.

The visionary ideas of organic farming are well developed in regard to crop production, where the farmer must rely on non-chemical techniques. On livestock farms, there often is not much difference between organic and conventional management, for example in regard to disease treatment or prevention. Some farmers considered the use of alternative medicine as something new, but had not undertaken other, more fundamental changes in their husbandry methods, such as breeding for increased disease resistance or introduction of more species-appropriate housing.

In addition, it should be noted and that the farming conditions of the animals significantly vary and are determined by climate, tradition, particularly the location and financial capabilities. However, there are standards, such as for European countries or the United States, which must comply with all organic farmers.

These dilemmas form a background for asking about the identity of organic animal husbandry. On the basis of its current status, what can we point to as relevant and realistic possibilities for its future development in theory and practice? For example, in recent years the understanding of animal welfare in organic farming has increasingly been discussed as including functional integrity and a striving towards 'naturalness'; how can this be integrated into daily practice?

Agricultural animals are an important integral part of the most organic farms. Agricultural animals are making a valuable contribution to the productivity and sustainability of organic farming systems, because occupy trophic niches that would otherwise not be used.

However, in order to create a sustainable agro-ecosystems, animal components must meet certain requirements:

1. Choice of species and breeds should be linked to crop production in the farm or in the region, as well as with local agro-climatic conditions.
2. The quantity of animals should be balanced depending on possibility of crop production and existing resource base.
3. Use of the given system should be designed so that to avoid drawing of harm to environment and to reduce to a minimum use of fossil fuels.

The role of animals

1. They provide food to human in forms of meat, milk and honey.
2. They utilize lands that are not suitable for cultivation to produce animas product foods of high value e.g. arid and semiarid areas, rocky and hilly topographies. Ruminants are able to convert waste crop by-products in high value human food.
3. They can be used to generate income when their surplus products are sold for cash. They also play the role of insurance in families where they are sold in case of emergencies like sickness and other eventualities that require immediate funds that may not have been planned for.
4. They play a social cultural role in terms of wealth expression, prestige, payment of dowry and other social obligations like worship.
5. They provide energy through draft power and domestic fuel e.g. dry cow dung and biogas.
6. They play an essential role in closing the carbon and nitrogen cycle in the ecosystems by

***Organic animal husbandry** is defined as a system of livestock production that promotes the use of organic and biodegradable inputs from the ecosystem in terms of animal nutrition, animal's health, animal housing and breeding. It deliberately avoids use of synthetic inputs such as drugs, feed additives and genetically engineered breeding inputs.*

provided in manure used for fertilizing the soil. The ash obtained by burning dung is incorporated in compost manure to provide nutrient for crops.

8.2 «Five Freedoms» of animals

The first documents that are more or less considering the rights of animals have appeared in the XVII century. Prior to that, «animal question» was the moral conscience of the individual. Pythagoras talked a lot about this, there is a famous quote by Leonardo da Vinci, a vegetarian and animal advocate: «The time will come when people will look at an animal killer, just as they look for the killer of man».

Ancestor of the legislative framework was England. At the beginning of the XIX century society seriously worried about animal rights. But all the proposed laws were rejected by Parliament: the animal was considered property, and giving them the right broke the law on the property.

Only in 1822 thanks to a member of Parliament Richard Martin was passed the first law, later called the «Martin's Act 1822» («Ill Treatment of Cattle Bill»). It was given royal assent on June 22 that year as An Act to prevent the cruel and improper Treatment of Cattle, and made it an offence, punishable by fines up to five pounds or two months imprisonment, to «beat, abuse, or ill-treat any horse, mare, gelding, mule, ass, ox, cow, heifer, steer, sheep or other cattle».

Soon English experience have adopted and in other countries. In 1850 he published the first law of animals in France, and in 1866 in the United States by type of British Royal Society is formed American Society for the Prevention of Cruelty to Animals (ASPCA). Subject animals became extremely popular, always organized the various groups opposed to vivisection and hunting, fur products, exploitation and use of animals for food. But legally this is not reflected.

During the world wars of the beginning and the middle of the XX-th century had no time for animal and any special legislative changes in their attitude did not descend. However, it is worth mentioning the law of 1933, enacted by the Nazis in Germany. On the one hand, Hitler was against cruelty to animals and for equality, on the other hand, according to this law, people as a kind of lost their status: in the first place were the Aryans, then went wolves, eagles and pigs, but then some of nationality, and Jews occupied the last place with rats.

Recovered after the Second World War, Europe has returned to the issue of animals. Since 60-ies began to appear different social movements in defence of animals. «Oxford group», «Animal Liberation Front» (now works in 38 countries), People for the Ethical Treatment of Animals (PETA) World Society for the Protection of Animals (WSPA).

Universal Declaration of Animal Rights was adopted by the International League of Animal Rights Sept. 23, 1977 in London. And on 15 October 1978, announced at the Paris headquarters of UNESCO. In 1979 he developed the «Five Freedoms». Later they brought in the Universal Declaration of animal rights.

The Five Freedoms are:

1. Freedom from Hunger and Thirst - by ready access to fresh water and a diet to maintain full health and vigour.

2. Freedom from Discomfort - by providing an appropriate environment including shelter and a comfortable resting area.
3. Freedom from Pain, Injury or Disease - by prevention or rapid diagnosis and treatment.
4. Freedom to Express Normal Behaviour - by providing sufficient space, proper facilities and company of the animal's own kind.
5. Freedom from Fear and Distress - by ensuring conditions and treatment which avoid mental suffering.

According to this Declaration, these «five freedom» should be provided to an animal's containing in the conditions of captivity.

The European Convention for the Protection of pets has been in the late eighties developed and published in November, 1987. Convention was signed by Austria, Belgium, Cyprus, Denmark, France, Germany, Greece, Iceland, Ireland, Liechtenstein, Italy, Luxembourg, Malta, UK, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, Turkey, Northern Ireland.

The civil code of the Russian Federation forbids cruel treatment of animals. And according to Article 245 of the Penal Code is considered a crime «cruelty to animals, which caused their death or injury if the act is done out of malicious motives or mercenary motives, or by using sadistic methods, or in the presence of minors».

8.3 Animal welfare and ethics in organic agriculture

Animal welfare is a question of the animals' quality of life (Sandoe, 1999) and is an area of increasing concern in Western society. In the European Union (EU), animals were officially recognised as sentient beings in 1997, in the Treaty of Amsterdam (EUR-Lex, 2003), with England, Austria and Norway being examples of countries implementing new and stricter animal welfare legislation. In the United States of America (USA), the large fast-food chains have joined efforts with the supermarkets to establish some animal welfare regulations for their suppliers (K. Brown, 2004).

In organic farming, there is a tradition of animal welfare concerns (S. Roderick, M. Hovi, 1999). The organic movement frequently identifies animal welfare as an important goal, but welfare is also an area where strong criticism regarding organic animal production has been expressed. While some have argued that organic animal husbandry represents the best possible welfare in contemporary farming, representatives from conventional agriculture have often been critical of the welfare of organic animals. Consumers have appreciated the organic way of raising animals (although this is not always reflected in the sales records of organic products), and animal welfare is regularly used as a positive marketing argument for organic animal products.

Although there is general agreement that animals should have a good quality of life, there is no agreement as to what this means in practice. И наука не всегда готова дать необходимый ответ на данный вопрос.

Even if we turn to science for advice, it will not be possible to give an indisputable answer to the question. Of course it is necessary to get all possible information and knowledge regarding how certain conditions affect the animals quality of life. However, animal welfare is not only a matter of facts. It is also a question of what is considered important in life (J. Tannenbaum, 1991). Researchers and philosophers have for several decades attempted to establish one definition of animal welfare, but today there is a common understanding that animal welfare is not only about facts, but also about values. Consequently, the interplay between facts and values, or between science and ethics, makes a single definition impossible.

The practice of ethics (i.e. normative ethics) scrutinizes our basic values: what we consider good or bad, right or wrong in life. Animal ethics in particular deals with the relationship between humans and animals and the norms that establish a good and right relationship. Fundamental questions such as the appropriate degree of welfare (do animals have a right to claims on welfare at all, or can they without further thought be used for human pleasure?) have to be addressed. If we decide that animals should be granted welfare, then in this world of limited resources, the next question to be answered is when is welfare good enough'?

Ethics also includes welfare quality: what is good quality of life for an animal? Therefore, when evaluating animal welfare issues in organic farming systems, we need to understand if particular organic Values can be used to help guide decisions regarding appropriate quantity and quality of animal welfare.

Organic values

Organic farmers are a heterogeneous group, having various goals and opinions. However, the development of organic farming, including standards for organic production, has been pursued by the organic movement based on some shared values. Organic farming has substantial roots in ecological and biological farming practices espoused in the early 20th century, and in the environmental movements from the 1970s and 1980s. Biodynamic farming is an exception, since it is based on the philosophy of Rudolf Steiner and his ideas about farming. However, in spite of this different philosophical background, practical biodynamic animal husbandry has much in common with that of other parts of the organic movement. Here biodynamic farming will not before the reconsidered.

It is possible to relate basic values in organic farming to ethical theories (V. Lund, 2006). Such theories dealing with the human-animal or human- nature relationship are often roughly divided into four categories depending on their focus ot moral concern (moral concern implies that humans in their actions must consider the interests or rights of those beings or entities encompassed by it). These categories include: atithropocentric, sentientistic, biocentric and ecocentric theories (M. Stenmark 2002):

1. anthropocentric theories argue that only humans have direct moral status;
2. sentientistic theories argue that all sentient beings have direct moral status;
3. biocentric theories defend the view that all living beings have direct moral status» regardless of sentience; and
4. ecocentric theories state that all species, ecosystems and other relevant features in nature have direct moral status.

The relationship among these different approaches is illustrated in Figure 8.1.

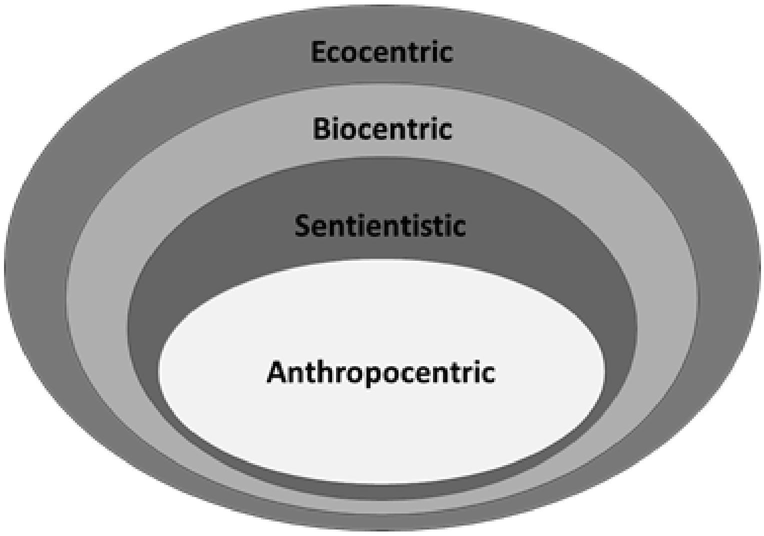

Figure 8.1 The four main categories for ethical theories dealing with questions regarding human- animal and human-nature relationships: anthropocentric, scientific, biocentric and ecocentric

As used here, these definitions do not deal with the question of intrinsic value, since it is theoretically possible to assign an entity intrinsic value but not direct moral concern; conversely, an animal can be the focus of moral concern but be independent of, or without, an intrinsic value

Thus, ecocentric ethics reflect that sustainability and establishment of sustainable systems are the main concern of organic farming. From the principles of organic farming (IFOAM) as well as IFOAMs published policy papers, it is clear that in general, the organic movement s primary goals focus on ecological sustainability rather than on animal welfare.

Organic farming is substantially based in ecocentric ethics. Ecocentric ethics largely responds to the same kind of issues that organic farming views as central, in particular the environmental concerns and the aim for a holistic view and such a view has consequences for how «quality of life» for farm animals is understood.

The ecocentric approach essentially sees the wellbeing of individual animals living in the systems as secondary to the wellbeing of the system itself. For example, the organic view is that treating animals with chemical substances, antibiotics or other compounds that may affect the ecosystem negatively should be avoided, irrespective of the consequences for individual animals. The use of such substances is also considered unsustainable since the microorganisms will eventually become resistant and there is the risk of food residues. Thus, the American national organic standards prohibit any use of antibiotics if products are to be labeled as organic (AMS-USDA 2000), while the EU allows a maximum of three courses of treatments with chemically-synthesized allopathic veterinary medicinal products or antibiotics' within one year (Council Regulation 1999).

Clearly ecocentric ethics do not offer an obvious focus from which to develop an animal ethics framework for organic farming. However, there are other less radical versions of ecocentric ethics where individuals are also considered to have moral significance. This ecocentric pluralism' assigns value both to ecological entities, such as ecosystems and species, and to individual organisms (M. Stenmark 2002). It can also be argued that ecocentric ethics is based on a fundamental respect for nature and recognises the interconnectedness among all living beings and between them and their environment; hence, animals (as well as humans) are inseparable and important parts of nature and must therefore be treated with care and respect. Consequently, animals can be seen to have moral standing and are more than just a means of production, deserving respect and consideration as important members of the ecological community. For example, some ecocentric philosophers, such as the Norwegian Arne Naess, argue that all living beings are united on a metaphysical level and accordingly, humans will also be harmed if animals are harmed.

The organic interpretation of the animal welfare concept can be compared with some common approaches to the concept (V. Lund, 2006):

1. The *subjective experience approach* argues that the welfare of the animal depends on how the animal experiences its situation; that is, what matters is its subjective feelings like pleasure, pain or fear

2. The *biological functioning approach* emphasises the animal's biological function, therefore welfare, can be measured through traits such as health, production and reproduction. Satisfactory performance of these functions implies that the animal has good welfare. In one of the most widely used welfare definitions, «coping successfully with the environment» is included along with biological functioning.

3. The *natural living approach*, proposing that an animal's welfare depends on the possibility of expressing its natural behaviour and living a natural life according to its genetically encoded nature or telos.

The third category is possibly in best accordance with organic values. Not only is natural behaviour important, but also food adapted to animal physiology and an environment similar to the biotope natural to the species are considered important. Studies of organic farmers suggest that they understand animal welfare primarily in terms of «natural living».

In the organic view, natural living is assigned a value in itself, and the fulfillment of the animals' natures ranks higher than the absence of pain and suffering. Natural living is considered not only as an instrument but also to have inherent value. As an instrumental value, it would be preferred only in as much as it would make the animal feel better or become healthier. Allowing animals a natural life is considered positive in itself, so that some negative experiences for the individual may be tolerated to achieve the positive. To an extent, negative experiences are perceived as a natural part of life that can never be completely removed from an individual animal's spectrum of experiences. This does not imply that such experiences are not negative for the individual as they happen, but rather that they are an important part of the functional feedback system connecting individual behaviour and the surrounding world.

Thus, in organic farming creating the natural conditions for animal life is the foundation of their well-being and this should serve as a starting point, when solved various problems of animal husbandry.

There is a potential in organic farming to create systems that give farm animals good welfare, and current research does not contradict this. However, there are some dilemmas caused by the underlying philosophy, and these must be recognized and discussed so that solutions can be found which promote animal welfare within the given framework. At the same time, the organic approach can open up for new ways of thinking and for innovative solutions. Organic farmers must take animal welfare issues seriously.

8.4 Conversion of conventional animal husbandry into organic animal husbandry

In countries where the development of organic farming, rules exist for the transition process from conventional to organic animal husbandry. For example, the EU adopted Regulation (EU) No 1804/1999 for organic livestock, which will include the necessary minimum requirements. These rules are constantly evolving, as some species of animals not yet included in the EU Regulation (such as rabbits, fish) and poorly specified (horses, goats). Some rules for the production has not yet filled (for example, there is a list of drugs approved for animals) are inaccurate and impractical.

The most important rules and standards for organic livestock production are the following:

- The transition of farm on organic farming.
- Minimum number of own feed on the farm.
- Limitations in feeding feed and feed additives.
- Strict instructions of the welfare for protection of animals
- Strict instructions of the housing for protection of animals.
- Lists of unauthorized drugs for animals.
- Instruction on transportation and slaughter of animals. Specific instructions on the care of animals.
- Precise control compliance.

At violation of operating rules sanctions are provided, up to deprivation of the status of the organic farm.

Only after a certain period of time just after the transition from conventional to organic production, farm receives the status of an organic farm. During this period the plant growing and animal husbandry functions within rules of organic agriculture. However, the produced forage can not yet be considered as ecological and animal production also do not have the status of organic. One year after the transition products are labeled as produced on the farm, in a state of transition to organic production. Only after two years production of plant growing receives designation of production made in organic agriculture. For production of animal husbandry there are specific terms of transition from conventional to organic animal husbandry (tab. 8.1).

Table 8.1 The transition from conventional agriculture to organic farming for agricultural land and livestock according to Regulation (EU) No 1804/1999

Animal species and the direction of their productivity	**The minimum standard (Regulation (EC) No 1804/1999)**
Pasture, arable land	24 months
Cattle meat productivity	12 months (at least three quarters of their lives)
Odd-toed ungulates (horses, donkeys) beef productivity	
Sheep, goats and pigs	6 months
Animals dairy productivity	6 months
Domestic poultry meat	10 weeks
Laying hens	6 weeks

Passage transition period confirmed by independent inspection agency. During the time of transition from conventional to organic livestock, farms are usually subsidized that depend on on many factors.

For example, during the transition to organic milk production, already after a 15-month period can be considered as organic milk and traded by Regulation (EU).

Regulation (EU) allows the transition to organic production only part of the farm. For example, transition to organic animal husbandry and preservation of usual (traditional) plant growing or transfer of dairy cattle to organic production and saving of the traditional maintenance of pigs. However desirable transfer of all branches of a farm to organic managing. It means, for example, that the farm should transfer all dairy herds to organic production, including and all agricultural grounds intended for production of forages. Two branches of the farm - one organic, the other traditional - must not overlap and touch. Only if the farm has two clearly lying at a distance from each other structural units (eg, cattle-breeding farm and agricultural land), and a significant distancing from one another can be documented, the farm can deal with both conventional and organic production products.

In the transition from traditional to organic farming can occur two situations:

1. Simultaneous transfer of an entire farm (livestock and crops): in this case, the transition continues at most 24 months. When feeding animals by sterns of own production, time of transition begins after the last feeding by conventional sterns. Time of last harvesting of forage crops in conventional crop production must be confirmed by independent regulatory agency. Time of transition can be shortened for a year for agricultural grounds which are used not by herbivores animals (chickens, pigs). As an exception, may shorten the transition to 6 months, if the inspection agency confirmed that in the recent past (about 6 months), no prohibited items in the livestock and feed production was used.
2. Transition to organic production only crop sector or livestock sector. When non-simultaneous transition fodder production and animal husbandry there is a need to purchase additional fodder or animals from organic farms. In this case it is necessary to establish the period of transition to organic farming for each animal species and for each products used in feeding

Currently, farmers' unions of organic agriculture and «IFOAM» promote rules that require the transfer of all the farms and do not allow the existence of a parallel conventional and organic farming (Б.Д. Насатуев, 2008).

9 Organic Standards and Certification

Organic farming is actively developing in the world and begins to develop in Russia. The global markets for eco-products are valued in 2010 at $ 59.1 billion a year. According to forecasts, by 2020 it could reach a turnover of $ 200-250 billion a year.

Most markets for ecological products, for example, of the European Union or the United States, formed as a result of the establishment and under the direct influence of the so-called directives and regulations, which define the necessary requirements for products, methods of production and allow marking it as «ecological» («organic», «biological», «bioorganic», «biodynamic», «bio», «eco»).

Regulations or standards - are the foundation is the legal framework defining the «rules» or «framework conditions» upon which the certification system, the market of environmental products, born of its producers and consumers.

The aim of certification is an assurance to the consumer by an independent competent authority (certification authority) that the product is indeed manufactured in accordance with standards of ecological production.

International Environmental Directives of production, which is certified, does not currently exist, and the bewildering number of «environmental» standards makes projecting environmentally oriented enterprises and farms, especially in the initial phase, very difficult (A.V. Khodus, 2004).

As of mid-2003, there were 39 countries where they were drafted and adopted the state standards and laws of bioorganic agriculture and on their basis certification of the enterprise (Figure 9.1). Most of these countries (29) is located in Europe, due to the fact that it originated here and was first to develop organic agriculture. The second category of countries with developed, but not in force a system of standards include the state, have developed their own standarts and laws, but which has not yet created a certification body. In 2003 there were 8 of these countries, of which 4 - Latin America (Brazil, Chile, Guatemala, Mexico), 2 - in Europe (Croatia and Estonia), as well as Egypt and Malaysia. The third part of the countries only began to develop "organic" standards and laws. These countries in the world, there are 15, 5 of them are in Asia (Georgia, China, Indonesia, Israel, Lebanon), 4 - America (Canada, Nicaragua, Peru, Saint Lucia), 3 - in Europe (Russia, Albania and Romania) and 2 - in Africa (South Africa and Madagascar) (A.Y. Mazurova, 2009).

Organic agriculture - an innovative direction and one of its objectives - is the preservation of local traditions and culture, and use the positive experience of agriculture, inherited from older generations. This is one of the reasons why the principles of bioorganic agriculture may differ in different countries, which creates, however, a number of problems. The consumer is difficult to understand in all sorts of principles and labelling listed on product packaging. This is particularly a serious problem for farmers, export-oriented their production to different countries, since they had to undergo several certifications for each of which must be paid. On the other hand, if we make the regulatory framework of the same for all countries, then you will lose the local specifics of agriculture. One way to solve the existing problem was accredited certification bodies of the organization IFOAM. This German company itself does not carry out certification of farms, but can check the certification authorities on the question their compliance with the requirements of minimum standards that are designed to IFOAM. Certification bodies that have passed this accreditation may put on product packaging special character «IFOAM ACCREDITED», which will increase consumer confidence (A.Y. Mazurova, 2009).

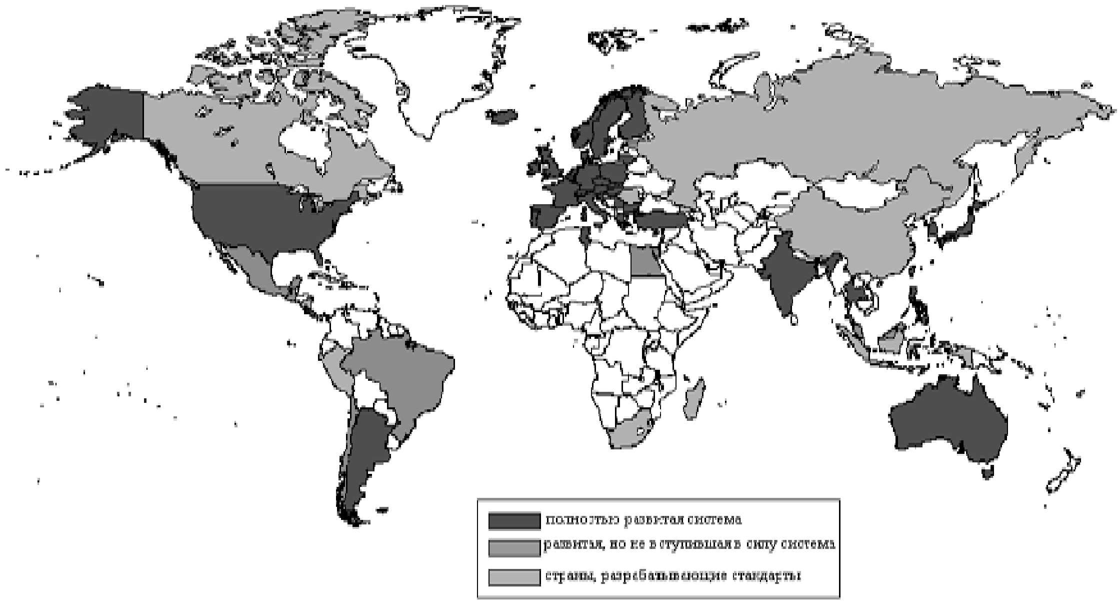

Figure 9.1 The level of development of national certification of organic farming (A.Y. Mazurova, 2009)

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The main types of ecological standards can be summarized as:

a) International private or intergovernmental framework of standards, such as the International basic standards of IFOAM (International Federation of Organic Agriculture Movements);

b) Basic operating standards or directives, such as the EU Directive (Council Regulation (EC) No 834/2007). United State Department of Agriculture/ National Organic Program (NOP). Japanese Agricultural Standard (JAS) for Organic Products.

c) Private Standards of ecological production, such as Demeter, Naturland, Bioland, Ecovin, Geae etc.

Among the international framework of standards (a) deserve special attention IFOAM Basic Standards. Their aim - to harmonize the various certification programs through the creation of universal framework conditions for environmental standards throughout the world. Currently, the certification cannot be used directly, and for ecological farms in tropical countries are not important. However, they may be useful for understanding the underlying principles and versions of all the ecological certification programs worldwide.

Basic operating standards (b) regulate certain ecological markets, ie determine the basic minimum "ecological" requirements that must be met for products and process of its production in accordance to labelling and the relevant market. There are different markets for ecological products, its individual requirements for certification, ie its own regulations and standards.

Despite of the various standards and directives, the products produced by similar rules of production and the result is equivalent to the efficiency of inspection activities.

Nevertheless, the production, which, for example, is exported to the European Union, must be certified in accordance with the requirements of EU Regulation for organic production, products that are exported to the U.S. - according to the National Organic Program (USDA).

European Union	USA	Japan	Australia	Germany	France	Canada

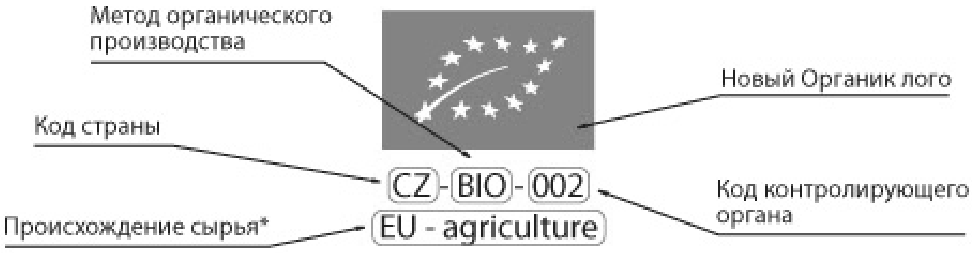
Figure 9.2 Labeling of ecological products in various countries around the world (*http://en.wikipedia.org/wiki/Organic_certification*).

On 01.07.2010, in accordance with EU regulations № 834/2007 and № 889/2008 introduced new requirements for labeling products «organic»:

1. Rule 95%: Products of "organic" must contain at least 95% of the ingredients of organic agriculture.

2. New Logo Organic: All products are "organic" is marked by a single European logo "organic" in the form of leaf:

3. The new single standardized code EU: Near the new logo is "organic" must be placed in a new unified and standardized code EU:



* When referring to the origin of agricultural raw materials - "EU-agriculture" - not less than 98% of ingredients should be delivered from the EU.

4. Direction of organic ingredients: The packaging of products «organic» must be specified ingredients obtained by organic agriculture.

5. Dates of sale of goods with the old labeling: Products with the old markings must be implemented no later than 01/01/2012.

Thus, buying the products labeled «organic», consumers can be assured that:

- At least 95% of the product ingredients are organic origin;
- Products conform to the official rules of certification and inspection control;
- Products supplied directly from the manufacturer or processor in a sealed package;
- On the product include the name of the manufacturer or processor, as well as the name or code of supervisory authority.

The **basic principles** of eco-certification are:

- control the production process, rather than the final product;
- control «from field to counter», ie all stages from creation to the final consumer (production, processing, sale, including importers and exporters);
- independence and impartiality of the certification authority.

Enterprises, ie producers, processors, retailers, importers and exporters wishing to label their products as «eco», «biological», «organic», «bio» and the like, must undergo an annual inspection and certification.

Depending on the market of certification is carried out on those or other standards. Therefore, when filling out applications for certification of customer indicates on which the market is expected to sell products - domestic, EU, U.S., Japan or other countries.

Certification pays for itself. Benefit the individual enterprise is the ability to label and sell their products as «eco», «biological», «organic» that may be beneficial, including, in the case of exports. Undoubtedly, the benefit is also that the company gets professional support in the field of quality management and the ability to improve the quality and production methods.

Certified, labeled the right way products ensures truly «ecological status» for consumers (I. Kondratiev, A.V. Khodus, 2004).

Another factor hindering the development of ecological farming and environmental management, ecological products market in Russia is the lack of acceptance at the state level legislative and regulatory framework. At the state level are still not defined what it means to the term «ecologica» and how such products should be made. Now everyone can mark their products as «eco», «biological», «organic» without incurring the consumer any additional obligations than many successfully used to gain a competitive advantage in the market. However, in Russia last year in this direction made significant strides.

One of the components of the Russian ecological standards is an eco-labeling. Just as in the European Union, the right of the Eco-label given to those companies whose products contain at least 95% of the "Eco" -ingredients - produced / imported in accordance with the Eco-standards. The remaining 5% should be permitted to be used ingredients in accordance with the «list of permitted substances». The right of the Eco-label is granted only if the manufacturing process was not used ionizing radiation.

Finally, the right to receive a eco-label have company that has supervisory control and confirmed the "ecological" status of its production. In this case, the marking includes the name and / or code number of the inspection authority responsible for the control.

However, it is extremely important «recognition» eco-mark for consumers. Consumers, when choosing a product, can not «keep in mind» a lot of different eco-labels with their private differences from each other. In addition, single label can focus your marketing efforts are not «spraying» in several areas (A.V. Khodus, 2005).

Description of the Russian ecological labels (http://www.ecounion.ru/ru/site.php)

► Eco-labels "Leaf of Life" (St. Petersburg, NP «St. Petersburg Ecological Union»)

The main characteristics of the eco-label «Leaf of Life»:

eco-labeling, a registered trade mark, is placed on product packaging, takes into account both national regulations and international standards, based on the basic requirements of a series of international standards ISO 14000, namely: ISO 14020, ISO 14024 (the standards have already been introduced in Russia as State Standards RF), includes an assessment of the life cycle for the same product group, is non-commercial, open to all potential participants. "Leaf of Life" can get any product successfully passed a voluntary ecological certification.

Voluntary certification procedure described by federal law «On technical regulation». Certification procedure for awarding eco-label «Leaf of Life» meets all the requirements of the law and is a qualitative complement to the existing legislation in the field of compulsory product certification. Today, voluntary certification endorsed at the level of the Administration of St. Petersburg and near-future eco-labeled product will have an advantage in the implementation of procurement within the state order.

Examination can be divided into the following thematic clusters: the examination of the final product manufacture (finished product), life cycle assessment of production, ie, accounting for all stages of production: from the quality of the raw materials to waste management, environmental audits (for labeling should be a positive conclusion environmental auditing procedure conducted by third party).

Simplified procedure for passing the examination can be visualized as follows:

- Step 1. By request of the company held a preliminary examination of the environmental quality of products (social assessment).
- Step 2. In-depth examination on the basis of expertise the St. Petersburg Chamber of Commerce and the Center for Testing and Certification «Test - St. Petersburg».
- Step 3. Consideration of examination results on the Public Advisory Board.
- Step 4. Issuance of certificate of right to use eco-labeling.

In the end, by a manufacturer receives the right to place the trademark on goods, which passed examination, and the right to use the mark in advertising products.

Validity of the label - 2 years. After this period will need to confirm that the product meets the criteria for eco-labeling procedures.

► The system of voluntary certification of «green products» (Moscow, NP "Moscow green products ")

The Moscow system of voluntary certification of «green products» was established in accordance with the Government of Moscow dated 16.09.03 № 783-PP «On Measures for environmental assessment of products sold in the consumer market in Moscow».

Organizational work for certification in the Certification System provides non-commercial partnership «Moscow green products» - The certification body.

Eco-friendly product - a product of animal or vegetable origin, produced from natural raw food grown in accordance with all established sanitary and veterinary norms and rules, as well as drinking water, packaged in containers that meet (appropriate) on safety levels set for food for young children.

Evaluation of products made on the basis of the rules developed by the Institute of Medical Sciences, Institute of Ecology and Environment of Sysin, TU Rospotrebnadzor.

Sampling is carried out by commissioning with mandatory participation of a representative of the customer through the purchase of the product in a shop in Moscow. The committee included representatives from the Department of Natural Resources and Environmental Protection in Moscow, the Department of Consumer Market and Services of Moscow, Department of Food Resources in Moscow, the State Inspectorate on the quality of Moscow, NP "MEP".

Tests conducted by the authoritative, accredited in the GOST R certification and accreditation system of the Russian Federation Ministry of Health laboratories and test centers, equipped with modern technology. Among them: Rostest-Moscow SOEX (ANO “Soyuzexpertiza”) RCCI, Biotest (MSU applied biotechnology), Princeton Academy of Food Industry of Moscow, SEC FSO of Russia, Laboratory of Hygiene of drinking water supply Institute of Human Ecology and Health Environmental, IL TU Rospotrebnadzor.

Expert assessment of environmental product produced by the documentation submitted to meet the requirements of the QMS to ISO 9001-2001. Scope of accreditation experts must necessarily include the type of product, which is subject to certification.

Conclusion of the expert for documentation, acts of sampling and testing protocols inventive product certification body sends to the City Commission, which consists of representatives of departments and public organizations of Moscow. The City Commission's decision to issue a certificate to the enterprise with the right product labeling familiar «green products». Taking into account the protocol City Commission, the certification authority (NP "MEP") makes the final decision on the recognition of conformity to all requirements of certification and issuance of certificate with the right-mark «Ecological product».

Products submitted for certification shall be made only from raw materials produced without the use of growth stimulants and feeding, pesticides, antibiotics, chemical fertilizers, hormones and veterinary drugs, genetically modified objects.

The manufacturer provides strict control throughout the fabrication of the circuit, starting with the selection of industrial areas, control of the technological chain, and the final product.

Certification Procedure: Admission and Registration Application - Decision on Application - Examination of documents stated on the certification of products - Decision on the further conduct of the certification of products - Order of the composition of the committee for selection of samples in a commercial network with a representative of the applicant - Sampling for testing of products - Testing product samples - Review of City Commission of certification results stated products - decision to issue a certificate or a reasoned refusal to issue a certificate - Registration Certificate - Conclusion of a contract to carry out the inspection control.

► The system of certification of ecological criteria (St. Petersburg, certification body ANO “TEST - St. Petersburg”).

The purpose of this certification system is to provide consumers with reliable information about the environmental properties of products. At the same time confirmed the conformity of this product requirements, enabling consumers to give preference to these products because of its environmental performance.

Evaluation of the characteristics (ecologicalal criteria) of products made on the basis of international standards ISO 14000.

The basic principles of certification criteria for environmental friendliness are: voluntariness, identification, feasibility, accessibility, evidence, privacy.

The objects of the criteria for ecological certification are: food products, water, packaged in a container, perfume and cosmetic products, oral hygiene products, light industry (clothing, textiles, footwear, leather goods and furs, toys); dishes; packaging , packaging, wood products and furniture.

Product Certification for environmental performance criteria conducted by a two-tier system - the choice of the applicant.

The first level of certification involves labeling production patented familiar with the logo of «ECO - Test – plus».

The second level of certification requires labeling of products familiar with the name "Leaf of Life". The second level of certification further provides for analysis of the product life cycle and ecological audit by a third party (independent organization).

Product certification criteria include environmental performance following are the steps: applying for certification, a decision on the application, the selection of samples, their identification and testing, analysis of production (according to the chosen scheme), the decision to grant a certificate issuing certificates and permits for the use of ecological label, preferred by environmental criteria, supervisory control of the certified products (according to the scheme).

Validity of the certificate establishes the certification authority, taking into account the term of the ND product, but no more than three years.

► The system of voluntary certification of «St. Petersburg in the quality mark» (St. Petersburg State University "Center for Quality Control of goods (products) and services")

The developer and owner of a St. Petersburg State Institution «Center for Quality Control of goods (products) and services».

The objects of certification in the system are almost all goods and services produced, performed, and providing local and international organizations of different legal forms of organization and individual entrepreneurs in the St. Petersburg market.

The order of certification in the «Petersburg mark of quality»: application for certification, consideration of the application and a decision on it; necessary inspections (document analysis, testing, production testing, quality management system, etc.), analysis of the results and decision on the possibility of issuing a certificate of conformity.

Mark of conformity system officially recognized by the administration of St. Petersburg as a city brand of quality and accordingly will be presented in the media. Center for Quality Control Authority of St. Petersburg has developed and implemented a program of advertising and branding support the promotion of Mark System and the System itself.

► The system of voluntary certification of "BIO" (Moscow Region, Inc. “Eco-Control”)

Environmental (biological, organic) products - are the products produced according to certain rules, which are enshrined in the directives or standards of ecological production. To confirm the ecological status of their products producers, processors and retailers are eco-certification, during which compliance is determined by production and production with environmental regulations.

Certification is available in the following areas: ecological agriculture, environmental, wild plants (mushrooms, berries, nuts, herbs, etc.), ecological wood, eco textiles, ecological aquaculture, etc.

The aim of eco-certification is an assurance to the consumer by an independent competent authority (certification authority) that the product really is made in accordance with the standards of ecological production.

The Russian producers of 2004, there was an opportunity to pass on the eco-certification established by «Eco Control» and officially registered GOSSTANDARD (Federal Agency for Technical Regulation and Metrology) system of voluntary certification of ecological and biodynamic farming «BIO».

The procedure for eco-certification can be divided into several stages.

- Stage 1. Collection and processing of prior information about the object of certification. These include filing a request, completing the application for certification and processing of primary information. The interested company announced its desire to certification, describes its activities and plan for ecological production, and also indicates the desired target markets. Certification authority is preparing an offer for the certification of the detailed costs and certain services. As soon as the company made its choice and signed with the organization for certification agreement on inspection and certification, it is officially in the certification process.
- Stage 2. Inspection of moving into the enterprise experts, data processing, resulting from inspections and expert opinion (inspectors) on the generated test, which is transmitted to the certification body. If necessary (the inaccessibility of information, lack of key staff during the inspection, etc.), the certification authority may impose additional inspection.
- Stage 3. Analysis of the findings and decision regarding the level of certification (product status). The decision on certification of the company reported its «ecological» status and the status of its production: «traditional», «conversion» or «ecological» (which is also reflected in the issued certificate), as well as the conditions and recommendations that must be done.
- Stage 4. Bringing information to the customer's certification.

Thus, at the end of the certification process, the applicant is issued Certificate, indicating the name and location of businesses, services, and / or products which are subject to certification, the name and volume of production, the standards against which certification is made, the degree of compliance with these standards, validity and limitations the certificate. Together with the certificate of the applicant may also have the right to use the Mark of Conformity Certification System "BIO".

Certification body may suspend or terminate the certificate by notifying the applicant.

Suspension or termination of the certificate is carried out in cases where there are considerable discrepancies standards certification systems «BIO», or not carried out corrective actions on nonconformities identified during a previous inspection compliance certification systems «BIO», or not complied with the conditions set forth in the contract inspection and certification or an applicant submitted a written statement that he would not comply with the conditions of certification.

Certificate issued by foreign certification body shall be valid unless it is issued by the certification body authorized to certify in accordance with those standards, and complies with the List of recognized certificates "Eco Control".

In all other cases it is necessary to provide relevant documents (standards, rules, inspection and certification documents, obtained through inspections, etc.). If necessary, can be carried out to experts, certified in the certification system «BIO», moving into the enterprise, products and / or services which are subject to certification.

Certification System «BIO» is carried out in co-correspondence to the following standards: Standards for Non-commercial Partnership for the development of ecological and biodynamic agriculture «AGROSOFIYA» «On organic farming, ecological, natural resources and related environmental labeling products», Council Regulation (EC) No 834/2007 «On organic production and labelling of organic products and repealing Regulation (EEC) No 2092/91», National Organic Program (NOP); Japanese Agricultural Standards (JAS); Standards biodynamic agriculture Demeter; others, not inconsistent with the purposes and principles of ecological and biodynamic farming, in accordance with the approved Ltd «Eco-Control» List of standards systems «Bio».

► Voluntary certification system "PURE DEW" (Moscow Region, NP “AGROSOFIYA”)

By non-commercial partnership «AGROSOFIYA» in 2005 was created SRT «AGROSOFIYA» «On Declaration of compliance with ecological standards", and then, and voluntary certification system «PURE DEW».

Now the faithful members of ecological industry can confirm the status of its environmental products and, accordingly, highlight it in a special way.

The aims of Certification System «PURE DEW» are: to promote sustainable development in agriculture and natural resources; promotion of the consumer with quality products, promote a market for ecological products in the Russian Federation and contribute to protecting consumers from products of domestic and imported, unnecessarily labeled as "ecological"; promote environmental conservation, promotion of competitiveness of Russian ecologictal products.

The purpose of certification is to guarantee the consumer that the product is indeed ecological.

The object of certification in the system is a way of declaration of conformity with ecological standards.

The procedure for eco-certification of the following:

Preliminary steps. The applicant must submit the certification authority application for certification in a free form for consideration, after which the applicant is to submit a bid (estimate) on conducting the certification procedure with detailed costs and certain services for approval and signature, as well as the contract is signed "Certification" with respect to the claimed subject matter certification .

Inspection. For inspection by Certification System «PURE DEW» certification body appointed an expert who agrees with the applicant the date of inspection, and then checks the conformity of the claimed subject matter certification system standards certification «PURE DEW».

At certification method declaration of conformity with ecological standards to check the documentation, and to disseminate information (labels, brochures, labels, Internet, media, etc.) with respect to environmental products;

Results of the audit are made expert opinion, which is transmitted to the certification body.

Assessment and awareness of the Customer. Certification body makes a request to the company «Eco-Control» about the authenticity of the certificate system «BIO». Ltd. «Eco-control» official letter confirms or denies specified in the Request for information. Based on analysis of the information and documents the decision on certification, which shall be communicated to the applicant's certification.

If a positive decision on the certification applicant is issued a certificate, which shall include the name and address of the list of products, the standards against which certification is made, the validity and limitations of the certificate. Together with the certificate applicant also obtains the right to use the Mark of Conformity Certification System «PURE DEW».

Suspension or termination of the certificate is carried out when towards the object of certification from "Eco-Control" received information about the suspension or termination of the Certificate System "BIO" or not complied with other conditions set forth in the Agreement on certification.

► The system of quality certification of CCK (model promising system to identify the most environmentally safe and quality products) (Moscow, Federal Agency of Certification)

Federal CA, working on their own quality certification system of CCK (The state registration № ROSS RU. 0001.040008 from 01.04.1994). We and our accredited certification bodies operating for almost 10 years on the Russian market, and now Ukraine. CCK - the only system that provides an objective quantitative assessment of quality and environmental friendliness of products with appropriate safeguards in the area of permitted use products, ie at the actual concentrations of hazardous substances no greater than the maximum permissible concentration (MPC). This attracts to us the best producers, the most environmentally friendly and quality products.

CCK system, developed by the International Academy of Social Development (LTD. "MAOR") and Federal Certification Center (DSF IREI), is designed for certification of industrial, agricultural, food and other products. It includes, besides conformity assessment, quantitative characteristics of quality (or environmental cleanliness) in contrast to other existing formal certification, which certify compliance with safety requirements only in rare cases, consistency with other indicators, without further assessment to improve the value of reducing harmful (toxic) substances below an acceptable level or increase the useful properties and high content of mineral supplements (such as vitamins, minerals, etc.).

Basic certification body is DSF IREI. Total for this system carried more than 50 accreditation and certification bodies in different cities of Russia and Ukraine, in particular, in St. Petersburg, Yekaterinburg, Vladivostok, Kaliningrad, Kazan, Donetsk, etc. Some of them are working very actively, encompassing not only his, but and several other areas.

Two main points distinguish the system of CCK from all other known prior to its certification:

- At its formation, we categorically rejected the primacy of the threshold of the principles in the evaluation of a certified facility (yes or no, pass - no pass);
- All variations of harmful substances from our standard method of "weighted" for human society, and after the convolution of weighted relations results of calculations (levels of environmental cleanliness and quality), determine the increase in the usefulness of this product with respect to the relevant regulations.

► The system of mandatory certification for environmental standards, Moscow certification body the «International Ecological Fund» (IEF OS)

On the basis of the International Facility operates certification body the «International Ecological Fund» (OS IEF), accredited in the system of mandatory certification for environmental standards ROSS.RU.001.01.ETOO. OS IEF conducts environmental certification on the following sites:

Objects subject to compulsory certification or declaration of compliance (on the list approved by the Government of the Russian Federation from 29.04.2002 № 287):

Objects subject to a voluntary environmental certification:

1. Environmental Management Systems of organizations to ISO 14001,
2. products subject to voluntary certification.

In a voluntary form of certified products, is not included in the lists of mandatory certification and declaration of conformity of products approved by the Government of the Russian Federation from 29.04.2002 № 287, as well as in the nomenclature of products, based on these lists, which was approved by Resolution 07/30 of the Russian State Standard 2002 № 64.

Environmental certification and environmental declaration of conformity OS IEF are the documents entitled: declare global level object confirmation, to establish incentive rates and allowances for their products as environmentally safe and natural, set tax, credit, insurance and other benefits in introducing low-waste technologies and production, the use of secondary resources, use and environmental labeling their products in accordance with international standards ISO 14020, 14021, 14024 and 14025, to advertise their products as environmentally safe and / or in-kind in the media and the Internet.

The ongoing work on the declaration of compliance

Eco-Declaration of Conformity can be registered body of environmental certification in one of 3 variant.

Variant 1 - Declaration was adopted by the applicant on their own, without the participation of accredited testing laboratories and certification bodies;

Variant 2 - the Declaration adopted by the applicant with the participation of laboratories; the applicant had the test, measurement, analysis of its production, performed the laboratory;

Variant 3 - the Declaration adopted by the applicant with the certification authority, the applicant has an environmental compliance certificate for environmental management system enterprise producing its products.

Control of products, compliance with which is confirmed by the declaration, shall, in accordance with the Resolution of RF Government of 7.07.99 № 766, the federal executive authorities and their territorial bodies under state control and supervision over the quality and product safety.

The procedure of certification of products in the mandatory and voluntary form includes the following steps.

- Step 1. Receipt of the application for certification by the certification body. Application materials must include: a list of products for which the applicant wishes to obtain certificates and the right to use eco-labelling, a list defining the regulations, a list of support calls for determining the normative documents, o Statement of product compliance with regulatory documents and their conformity with world standards in this area.

  Confirmed by determining the requirements of normative documents are selected in accordance with the mandatory safety requirements. In the absence of such a document, these requirements are chosen from similar international instruments - UN / ECE Regulations, EEC directives, «COMPLIANCE», «Ekoteks-100», etc.

  In a statement the applicant under the application object regulatory requirements should be stated that the applicant under our sole responsibility states that he submitted to the certification of facilities fully comply with these regulations (hereinafter referred to is a list of these documents.

  The application must include an obligation to pay the certification work, regardless of their results (the result can be either positive or negative).

- Step 2. Examination of the application materials and the establishment of the verification scheme of certification object. The examination of the application materials authority to pursue the certification scheme.

  In order to establish a certification scheme authority must: identify the type of products according to GOST R 51293-1999; assess the harmful effects of products on the environment, including the type and nature of adverse effects; establish the need for laboratory tests and to identify indicators of harmful effects of products on the environment to determine the list confirmed by the certification requirements and, as a consequence of that list - the need for a hygienic certificate, veterinary certificate, fire safety certificates, permits RTN, check the list of support calls, assess the potential material cost of the applicant in the implementation of the verification scheme.

  After the establishment of a certification scheme authority enters into a contract with the applicant for certification of products.

- Step 3. Checking products. Sampled products for testing, if it is stipulated by the certification scheme. Samples were sent to the testing laboratory that performs testing facility certification.
- Obtained in the laboratory values of indicators of production (confirmed by the requirements) are compared with the authority figures submitted by the applicant of normative documents for compliance with that body prizvoditsya product certification.
- By comparing the results of the organ, an instrument of verification products, which should contain a conclusion about the possibility or impossibility of issuance of the certificate to the applicant.
- Step 4. Issuance or refusal of a certificate.
- Step 5. Conclusion of the contract between the authority and the holder of the certificate on the conditions of inspection control.
- Step 6. Entering information into the register issued certificates of authority and direction of the information to the accrediting body of the Certification Scheme in the form of facsimile copies of documents issued.
- Step 7. Inspection control over the activities of holders of certificates, including the validation mark certified facilities.

Holders of certificates (declaration) in coordination with the certification body is entitled to apply eco-labels, additional to the basic eco-label, provided that the additional eco-labeling complies with GOST R ISO 14020-1999, ISO 14021-2000, ISO 14024-2000, GOST R 51956-2002, GOST 51074-2003, GOST 51150-1998, GOST 51293-1999, GOST 51760-2001.

Eco-labeling is carried out in the form of a graphic image or in the form of verbal language.

According to the Rules of the conformity mark of the environmental certification ROSS RU. 001.01. Eto'o and eco-labeling in the OS IEF holders of certificates of environmental compliance and environmental declarations of conformity issued (registered) by Certification International Ecological Fund "(OS IEF), have the right to label their products and accompanying documentation to: eco-label compliance, environmental labeling.

For holders of certificates (declaration) issued (registered) operating system IEF, eco-labelling is a graphical representation of a trademark registered by Rospatent (certificate number 196553) with an inscription in a circle "Environmental Certificate of Compliance" or "Eco-Declaration of Conformity."

► The trademark «Healthy food. Leningrad region» (Leningrad region, the Office of Federal State Employment Service of the Leningrad Region)

The main objectives of certification are: improving product quality by creating an environment for open and free competition of enterprises in the single market for goods and services, protecting consumers from unscrupulous activities of the manufacturer of products; confirmation of quality products, including environmental cleanliness (hereinafter: the quality indicators), claimed manufacturer (performer); confirmation of the availability of the manufacturer (applicant) to produce products with stable quality indicators, to facilitate consumers to make a competent choice of products, promoting improved quality of life and health for sustainable development of society, promotion of environmental protection from pollution.

The certification process conducted determining actual values of quality and / or environmental product, compliance with the requirements of these indicators and assessment of the degree of improvement with respect to these requirements, actual values of products as a preferred customer and company direction, which is reflected on the certificate in the form of additional information.

Conformity of production (including environmental) is carried out by comparing actual performance with the basic requirements (performance), established in the standards.

System is open to the participation of enterprises and organizations of various forms of ownership, individual entrepreneurs and other individuals interested in the activities of voluntary certification.

The order of examination:

To sign the contract and receipt of the certificate applicant submits to the Certification Statement. The following documents are attached to the statement.

For legal entities: a copy of the document confirming the state registration, a copy of the Charter of the legal person, a copy of the document confirming registration with the tax authority.

For individuals: a copy of identity document, a copy of the document confirming registration with the tax authority.

Certification body of an invoice the applicant for carrying out certification procedures. Competitor pays the bill and submits to the certification body document confirming the payment.

Within 15 (fifteen) working days from the date of the registration statement of the applicant certification body carries out activities in the collection, quality assurance and compliance with safety designs.

The results of the examination are issued in the form of detention.

Upon receipt of the conclusion of the certification body shall notify the applicant and invites you to a meeting of a special commission of the Government of the Leningrad region. With the positive conclusion of examination the applicant shall be invited for contract and certificate.

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Glossary

Agricultural biodiversity - the component of biodiversity that is relevant to food and agriculture production. The term agrobiodiversity encompasses genetic species and ecosystem diversity.

Agricultural intensification – refers to any practice that increases productivity per unit land area at some cost in labour or capital inputs. One important dimension of agricultural intensification is the length of fallow period (i.e. letting land lie uncultivated for a period) and whether the management approach uses ecological or technological means.

Agritourism – Agritourism is a style of vacation in which hospitality is offered on farms. Agri-tourism can refer to various kinds of small farms seeking to diversify their enterprises to strengthen their financial position.

Agrochemical – agrochemicals are commercially produced, usually synthetic, chemical compounds used in farming such as a fertilizer, pesticide or soil conditioner.

Agroecosystem – a semi-natural or modified natural system managed by humans for food and agricultural production purposes.

Agro-ecotourism (eco-agritourism) – eco-agritourism combines rural tourism (agritourism) and ecological tourism (eco-tourism) with farm hospitality and enjoying neighbouring natural landscapes.

ATTRA – National Sustainable Agriculture Information Service in USA.

Biodiversity – The variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems.

Biodynamic agriculture – Biodynamic agriculture considers both the material and spiritual context of food production and works with terrestrial as well as cosmic influences. The influence of planetary rhythms on the growth of plants and animals, in terms of the ripening power of light and warmth, is managed by guiding cultivation times with an astronomical calendar. All organic principles apply to biodynamic farming, gardening and forestry. A specific feature of biodynamic agriculture, inspired by Rudolf Steiner (1861-1925) is the regeneration of the forces that work through the soil to the plant by using compost and spray preparations from naturally fermented organic substances in minute doses to soils and crops. The aim is to harvest crops which not only have substances but also vitality. The use of biodynamic preparations has been shown to have substantial restoration power on exhausted soils and biodynamic animals seem to have better resistance to infection.

Biological pest control – biological control is a method of controlling pests, diseases and weeds in agriculture that relies on natural predation, parasitism or other natural mechanisms that restrain the development of pathogenic organisms. The control of living organisms (especially pests) by biological means. Any process using deliberately introduced living organisms to restrain the growth and development of other, very often pathogenic, organisms, such as the use of spider mites to control cassava mealy bug. The term also applies to the use of disease-resistant crop cultivars. Biotechnology approaches biocontrol in various ways, such as using fungi, viruses or bacteria, which are known to attack an insect or weed pest.

Carbon sequestration – conversion, through photosynthesis, of atmospheric carbon leading to the long-term storage of carbon in the soil and in living and dead vegetation. Carbon stored can offset carbon dioxide released. Therein lies the possibility of agriculture providing a valuable service to society by storing carbon that offsets the carbon dioxide that is emitted by other sectors.

Catch crop – a rapidly growing plant that can be intercropped between rows of the main crop; often used as a green manure.

Companion planting – crops that are planted close to one another to achieve some mutual benefit such as repelling insect pests or attracting beneficial insects, shade, wind protection, support, or nutrient enrichment.

Compost – a mixture of decaying organic matter, as from leaves and manure, used to improve soil structure and provide nutrients.

Conservation agriculture – conservation agriculture aims to achieve sustainable and profitable agriculture and subsequently aimes at improved livelihoods of farmers through the application of the three CA principles: minimal soil disturbance, permanent soil cover and crop rotations.

Conservation tillage – it is a practice used in conventional agriculture to reduce the effects of tillage on soil erosion, however, it still depends on tillage as the structure forming element in the soil.

Conventional agriculture – what is accepted as the norm and is the most dominant agricultural practice. Since World War II, (mainly in the industrialized world), conventional agriculture has become an industrialized form of farming characterized by mechanization, monocultures, and the use of synthetic inputs such as chemical fertilizers, pesticides and genetically modified organisms (GMOs), with an emphasis on maximizing productivity and profitability and treating the farm produce as a commodity. In large parts of the developing world, agriculture is still "traditional", ranging from well-managed polycultures to extensive and eroding pastures.

Cover crop – a crop grown to prevent soil erosion by covering the soil with living vegetation and roots that hold on to the soil. Cover crops are also grown to help maintain soil organic matter and increase nitrogen availability (green manure crop), and to “hold on” to excess nutrients (a catch crop) still in the soil, following an economic crop. Other benefits of cover crops include weed suppression and attraction of beneficial insects.

Crop rotation – the practice of alternating the species or families of annual and/or biannual crops grown on a specific field in a planned pattern or sequence so as to break weed, pest and disease cycles and to maintain or improve soil fertility and organic matter content.

Eco-labelling – voluntary method of environmental performance certification and labelling. An "ecolabel" is a label which identifies overall environmental preference of a product or service based on life cycle considerations. In contrast to "green" symbols or claim statements developed by manufacturers and service providers, an ecolabel is awarded by an impartial third-party in relation to certain products or services that are independently determined to meet environmental leadership criteria.

Ecological agriculture – ecological agriculture is a management system that enhances natural regenerative processes and stabilize interactions within local agro-ecosystems. Ecological agriculture includes organic agriculture as well as other ecological approaches to farming that allow the use of synthetic inputs. In Spanish, however, ecological agriculture is a legally protected term that refers to organic agriculture.

Ecosystem – a natural entity (or a system) with distinct structures and relationships that interlink biotic communities (of plants and animals) to each other and link them to their abiotic environment. The study of an ecosystem provides a methodological basis for complex synthesis between organism and their environment. A complex of ecosystems is constituted of many ecosystems and is characterized by a common origin or common dynamic processes (for example, the complex of ecosystems of a watershed).

Eco-tourism (ecological tourism) – travel to a pristine natural area that appeals to environmentally conscious individuals. An integral part of ecological tourism is the promotion of recycling, energy efficiency and water conservation in order to minimize their impact and conserve the environment.

Erosion control – erosion control is the practice of preventing or controlling wind or water erosion in agriculture, land development and construction. This usually involves the creation of some sort of physical barrier, such as vegetation or rock, to absorb some of the energy of the wind or water that is causing the erosion. Effective erosion controls are important techniques in preventing water pollution and soil loss.

Fair trade – fair trade is a trading partnership, based on dialogue, transparency and respect, which seeks greater equity in international trade. It contributes to sustainable development by offering better trading conditions to, and securing the rights of, marginalized producers and workers – especially in the South.

Genetically modified organism (GMO) – a genetically modified/engineered organism means an organism in which the genetic material has been changed through modern biotechnology in a way that does not occur naturally by multiplication and/or natural recombination. For instance, a plant may be given fish genetic material that increases its resistance to frost. Another example would be an animal that has been modified with genes that give it the ability to secrete a human protein.

Green manuring – green manuring refers to a cover crop grown to help maintain soil organic matter and increase nitrogen availability. Legumes are often used because they have rhizobial bacteria living in their root nodules that are able to fix nitrogen from the air and add it to the soil. Green manure is incorporated into the soil for the purpose of soil improvement. May include spontaneous crops, plants or weeds.

Humus – decomposed, dark brown and amorphous organic matter of soils, having lost all trace of the structure and composition of the vegetable and animal matter from which it was derived. Humus hence refers to any organic matter that has reached a point of stability and which is used in agriculture to amend soil.

IFOAM – International Federation of Organic Agriculture Movements.

Industrial agriculture – industrial agriculture is a form of modern farming that refers to the industrialized production of livestock, poultry, fish, and crops. The methods of industrial agriculture are technoscientific, economic and political. They include innovation in agricultural machinery and farming methods, genetic technology, techniques for achieving economies of scale in production, the creation of new markets for consumption, the application of patent protection to genetic information, and global trade. These methods are widespread in developed nations and increasingly prevalent worldwide.

Integrated pest management (IPM) – integrated pest management (IPM) means the careful consideration of all available pest control techniques and subsequent integration of appropriate measures that discourage the development of pest populations and keeps pesticides and other interventions to levels that are economically justified and reduce or minimize risks to human health and the environment. IPM emphasizes the growth of a healthy crop with the least possible disruption to agro-ecosystems and encourages natural pest control mechanisms.

Intercropping – growing two or more crops as a mixture in the same field at the same time. Intercropping can be one way of adding diversity to a crop system.

Landscape ecology – landscape ecology is the study that embraces geomorphology and ecology and is applied to the design and architecture of landscapes, including agriculture and buildings. Conceptually, landscape ecology considers the development and maintenance of spatial heterogeneity on biotic and abiotic processes, and management of that heterogeneity. The conservation of high quality or traditional landscapes and biodiversity requires integration of farmlands, natural vegetation and water bodies.

Legume-based organic rotation – a traditional component of crop rotation is the replenishment of nitrogen through the use of legumes in sequence with other crops. Legume-based rotations increase soil fertility by fixing nitrogen.

Mineral fertilizer – fertlizers manufactured by chemical and industrial processes. May include products not found in nature, or simulation of products from natural sources (but not extracted from natural raw materials). It refers to agricultural substances produced through chemical processes, including nitrogen-fertilizers.

Minimum tillage – minimum tillage is a tillage method that does not turn the soil over, with a view to maintain biodiversity structure.

Monocropping – monocropping refers to specialized cultivation of one crop on a farm (often large plantations) and planting the same crop year after year, without rotation or follows. While monocropping is economically efficient in capital intensive enterprises, specialization leads to increased use of synthetic inputs to keep pest and diseases under check and fertilize the soil. Besides the high risk of crop failure in monocultivations, environmental externalities pose serious problems to the sustainability of natural resources and public health.

Mulching – a protective covering, usually of organic matter such as leaves, straw, or peat, placed around plants to prevent the evaporation of moisture, the freezing of roots, and the growth of weeds.

Multicropping – planting two or more species in the same field during the same growing season. It can take the form of double-cropping, in which a second crop is planted after the first has been harvested, or relay cropping, in which the second crop is started amidst the first crop before it has been harvested.

Organic agriculture (biological farming) – organic agriculture is a holistic production management system which promotes and enhances agroecosystem health, including biodiversity, biological cycles, and soil biological activity. It emphasizes the use of management practices in preference to the use of off-farm inputs, taking into account that regional conditions require locally adapted systems. This is accomplished by using, where possible, cultural, biological and mechanical methods, as opposed to using synthetic materials, to fulfill any specific function within the system.

Organic agriculture standard – organic standards have long been used to create an agreement within organic agriculture about what an "organic" claim on a product means, and to some extent, to inform consumers. It includes recommended and prohibited practices and substances as well as guarantee requirements. Regional groups of organic farmers and their supporters began developing organic standards as early as in the 1940's. Currently there are over 450 private organic standards worldwide; and in addition, organic standards have been codified in the technical regulations of more than 60 governments.

Organic and fair trade – this adjective refers to two different labels and premiums involved. More than half of fair trade food is organic but organic is not necessarily fair trade and viceversa. An IFOAM standard includes "social justice" within organic standards but not Codex or government regulations.

Organic aquaculture – aquatic species produced according to organic standards. Most reported certified organic aquaculture products produced in Europe use marine and brackish waters, a largely untapped resource, thus preserving fresh water supplies for human consumption and agriculture. Aquaculture also covers organic aquatic plants for either direct human consumption or for use as feed inputs for animal husbandry, including for the organic aquaculture sector.

Organic breeding – according to IFOAM, the general principle for organic breeding is that breeds are adapted to local conditions. IFOAM recommends that breeding goals should encourage and maintain the good health and welfare of the animals consistent with their natural behaviour. Breeding practices should include methods that are not capital intensive methods or depend on high technologies invasive to natural behaviour. Animals should be bred by natural reproduction techniques. Standards should require that breeding systems shall be based on breeds that can reproduce successfully under natural conditions without human involvement. Artificial insemination is permitted. Hormones are prohibited to induce ovulation and birth unless applied to individual animals for medical reasons and under veterinary supervision.

Organic certification – certification is the procedure by which officially recognized certification bodies, provide written or equivalent assurance that foods or food control systems conform to requirements. Certification of food may be, as appropriate, based on a range of inspection activities which may include continuous on-line inspection, auditing of quality assurance systems and examination of finished products.

Organic conversion – process of change into an organic agricultural system from a different management system, industrial or traditional or integrated it may be.

Organic ecosystem management – management that includes principles, recommendations and requirements for maintaining and improving: landscape and biodiversity quality; soil and water quality; prohibition on clearing primary ecosystems; exclusion of genetic engineering from organic production and processing; and prevention of degradation of common/public lands when harvesting or gathering wild products.

Organic farm – any farm which uses the organic farming practices. Organic farming is more than agricultural production without the use of synthetic chemicals or genetically modified organisms, growth regulators, and livestock feed additives. Organic farming emphasises a holistic farm management approach, where rotations and animals play an integral role to the system.

Organic fertilizer – a biofertilizer is a natural fertilizer that helps to provide all the nutrients required by the plants and to increase the quality of the soil with a natural microorganism environment. For instance, the production and use of biofertilizer (e.g. seaweed products; compost) is proposed to improve crop yields by using root nodule bacteria (rhizobia), mycorrhizal fungi, and other microorganisms that are able to increase the accessibility of plant nutrients from the soils.

Organic food processing – organic food is to be processed by biological, mechanical and physical methods in a way that maintain the vital quality of each ingredient, the finished product and nutritional value. Processors should choose methods that limit the number and quantity of non-organic additive and processing aids. Any additives, processing aids or other material that chemically react with or modify organic food shall be restricted. Irradiation is not permitted. Filtration equipment shall not contain asbestos, or utilize techniques or substances that may negatively affect the product. The following conditions of storage are permitted: controlled atmosphere, temperature control; drying and humidity regulation. Use of approved processing aids includes: drying with ascorbic acid, citric acid, tartaric acid and salt; blanching with high temperatures to destroy micro-organisms; pasteurizing to destroy micro-organisms that could contaminate the product after blanching; and with heat treatments that conserve products by destroying or inactivating enzymes and killing micro-organisms.

Organic matter (OM) – plant and animal residues at various stages of decomposition, cells and tissues of soil organisms, and substances synthesized by the soil population.

Organic pest management **–** today, insect pest management in organic agriculture involves the adoption of scientifically based and ecologically sound strategies as specified by international and national organic production standards. These include a ban on synthetic insecticides and, more recently, on genetically modified organisms (GMOs). Pest management in organic systems differ from conventional agriculture conceptually in that indirect or preventative measures form the foundation of the system, while direct or reactive control methods are rare and must comply with organic production standards. Pest control in organic agriculture begins by making sensible choices, such as growing crops that are naturally resistant to diseases and pests, or choosing sowing times that prevent pest and disease outbreaks. Substituting synthethic pesticides with biological pest control substances is part of the strategy during conversion but is not economically efficient neither desirable once the pest-predator balance is re-established in the system.

Organic soil fertility management – organic soil fertility management is guided by the philosophy of "feed the soil to feed the plant". This basic precept is implemented through a series of practices designed to increase soil organic matter, biological activity, and nutrient availability.

Permaculture – permaculture (permanent+agriculture) is the conscious design and maintenance of agriculturally productive ecosystems which have the diversity, stability, and resilience of natural ecosystems. It is a land use and community building movement which strives for the harmonious integration of human dwellings, microclimate, annual and perennial plants, animals, soils, and water into stable, productive communities. The focus is not on these elements themselves, but rather on the relationships created among them by the way we place them in the landscape. This synergy is further enhanced by mimicking patterns found in nature. It is a system of assembling conceptual, material, and strategic components in a pattern which functions to benefit life in all its forms.

Soil carbon sequestration – biogeochemical process where soils take up and fix carbon. Soil carbon sequestration is one of the most promising options for climate change mitigation with a wide range of synergies. By increasing carbon concentrations in the soil through better management practices, this option offers benefits for biodiversity, soil fertility and productivity, and soil water storage capacity. Further, it stabilizes and increases food production reversing land degradation and restoring the health of ecological processes.

Soil compaction – soil compaction occurs when weight of livestock or heavy machinery compresses soil, causing it to lose pore space. Affected soils become less able to absorb rainfall, thus increasing runoff and erosion. Plants have difficulty in compacted soil because the mineral grains are pressed together, leaving little space for air and water, which are essential for root growth. Burrowing animals also find a hostile environment, because the denser soil is more difficult to penetrate.

Soil erosion – geologically, erosion is defined as the process that slowly shapes hillsides, allowing the formation of soil cover from the weathering of rocks and from alluvional and colluvial deposits. Erosion caused by human activities, as an effect of careless exploitation of the environment, results in increasing runoffs and declined arable layers and crop productivity. For example, bare land is more likely to be weathered by physical forces such as rainfall, flowing water, wind ice, temperature change, gravity or other natural or anthropogenic agents that abrade, detach and remove soil or geological material from one point on the earth's surface to be deposited elsewhere.

Soil fertility – ability of soil to produce and sustain a plant cover. Soil fertility is the cornerstone of organic management. Because organic farmers do not use synthetic nutrients to restore degraded soil, they must concentrate on building and maintaining soil fertility primarily through their basic farming practices. They depend on multicropping systems and crop rotations, cover crops, organic fertilizers and minimum tillage to maintain and improve soil quality.

Soil health – the terms soil quality (favoured by scientists) and soil health (favoured by farmers) tend to be used interchangeably. Characterization of soil quality by scientists focuses on analytical/quantitative properties of soil with a separately defined quantitative link to the functions of soil quality. Characterization of soil health by farmers focuses on descriptive/qualitative properties of soil with a direct value judgement (unhealthy to healthy) integrated into the options for a given property; in addition, interwoven into the properties of soil per se are valuebased descriptive properties of plant, water, air, and animal/human systems considered by farmers to be an integral part of soil health characterization.

Soil organic matter (SOM) – soil organic matter (SOM) is defined as all organic materials found in soils irrespective of origin or state of decomposition. It can be divided into three general pools: living biomass of micro-organisms, fresh and partially decomposed residues, and the well-decomposed and highly stable organic material, or humus.

Traditional agriculture (traditional farming system/ TFS) – traditional agriculture, is an indigenous form of farming, result of the coevolution of local social and environmental systems and that exhibit a high level of ecological rationale expressed through the intensive use of local knowledge and natural resources, including the management of agrobiodiversity in the form of diversified agricultural systems.

Transgenic organism – an organism in which a foreign gene (a transgene) is incorporated into its genome. The transgene is present in both somatic and germ cells, is expressed in one or more tissues, and is inherited by offspring in a Mendelian fashion.

Transition from conventional to organic – it refers to a production system which follows organic management practices, but has not yet fulfilled time requirements to be certified organic, as land and water need to be purified from residues of synthetic inputs.

Vermicomposting – vermicompost (or worm compost) the process of using earthworms to breakdown kitchen and garden waste, to create a faster than normal composting. Compared to ordinary soil, the earthworm castings (the material produced from the digestive tracts of worms) contain five times more nitrogen, seven times more phosphorus and 11 times more potassium. They are rich in humic acids and improve the structure of the soil. The earthworm most often to be found in the compost heap is Brandling Worms (Eisenia foetida), or Redworms (Lumbricus rubellus). This species is only rarely found in soil and is adapted to the special conditions in rotting vegetation, compost and manure piles. Earthworms are available from mail-order suppliers, or from angling shops where they are sold as bait. Small scale vermicomposting is well suited to turn kitchen wastes into high quality soil where space is limited. In addition to worms, a healthy vermicomposting system hosts many other organisms such as insects, moulds, and bacteria.

Zero tillage (no tillage, no till) – zero tillage is the simple technique of drilling seed into the soil with little or no prior land preparation. Zero tillage is a technical component used in conservation practising conservation agriculture, but not everyone carrying out zero tillage is practising conservation agriculture.

Organic agriculture market – organic markets are growing but reactive, driven by food safety concerns and to a lesser extent, by environmental awareness. They often establish producer-consumer groups to provide direct food marketing through such activities as farmers' markets or home deliveries to subscribed customers, which increases profits.

Annex: Training material

The elaborated RUDECO modules serve for the purpose of "Vocational Training in Rural Development and Ecology" in Russia. They target on representatives of local and regional administrations and advanced students in the different fields of rural development.

All below listed RUDECO partners can be addressed in case of training interest in one of the modules. For readers of the module textbooks and training participants the project website provides the possibility to download additional material on **http://tempus-rudeco.ru/en/modules** (required password **RD-modules**), e.g. presentations and other didactic material used in the conducted trainings.

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