

**CODE OF GOOD
AGRICULTURAL
PRACTICE
FOR LATVIA**

JELGAVA, 1999

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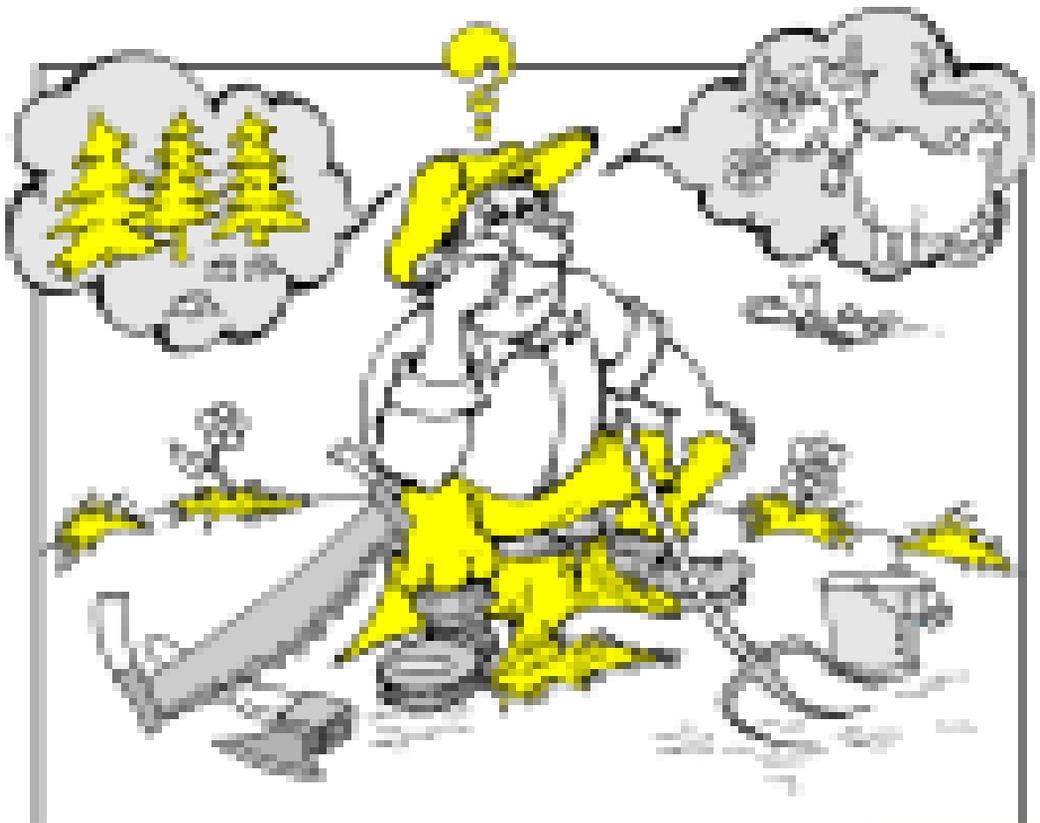
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INTRODUCTION



The Code of Good Agricultural Practice (GAP) was prepared by the Danish-Latvian joint project with the participation of Swedish experts. The Danish Environmental Protection Agency, the Ministry of Agriculture of Latvia and the Latvian Environmental Protection Fund financed the project. The responsible **executor institutions** are the Danish Agricultural Advisory Centre and Latvia University of Agriculture. A large number of Latvian experts from research institutions, associations of farmers, advisory services as well as other governmental and non-governmental organisations were involved in the development and evaluation of GAP Code.

The Code of GAP has been elaborated to comply with the requirements of the EU Nitrate Directive, which Latvia has obliged itself to implement during the process of preparation for EU membership. At the same time The Code of GAP contains various recommendations of the Helsinki Commission.

It is important to note that the Code of GAP also provides several concrete recommendations for good agricultural practices. Only codes written in shadowed text boxes are compulsory as they refer to the existing Latvian legislation.

Code of GAP for Latvia has been endorsed by the Ministry of the Agriculture (June 1, 1999), and the Ministry of Environmental Protection and Regional Development (June 8, 1999) of the Republic of Latvia.

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The specialists from the Swedish Institute of Agricultural Engineering consulted the project.

The Code of GAP is not a complete document, it will be periodically supplemented to include new ideas and opinions, to balance the economy of agricultural production with social and environmental conditions, and to establish gradually a model of sustainable development. Authors would be very grateful for every proposal and evaluation that is sent to the following address:

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The Code of Good Agricultural Practice contains legislation obligations, recommendations and practical advice envisaged for farmers, horticulturists, individual growers, agriculture service employees and for everyone who is involved in agricultural production and preservation of rural environment. The aims of the Good Agriculture Practice (GAP) are to decrease the negative influence of farming on the environment and to prevent the impoverishment and irrational use of the main nature resources – soil, water, plants, animals, and landscape. It is recommended to follow the rules accepted in Europe and in other developed countries, so that Latvian goods would not meet barriers in international markets and our rural environment would remain attractive for tourists. GAP comprises main spheres of agricultural activities that are critical in causing water, air, and soil pollution. It gives advice for the prevention or at least for the decrease of pollution. A successful implementation of GAP has to be based on three integrated basic principles: economically viable, environmentally friendly, and socially acceptable.

A determined introduction of a correct farming today can ensure a growing financial support both from Latvia and the European Union.

The society in general as a consumer regards countryside not only as a source of qualitative and healthy food, but also as an acceptable space for living and multifarious recreation possibilities with growing interest how to save the natural environment.

The goal to establish GAP Code for each country is determined by the Nitrate Directive of the European Union (EEC/91/676). It is therefore important that this work is accomplished on Latvia's way towards full membership in the EU. The Helsinki Convention on the Protection of the Marine Environment of the Baltic Sea Area (HELCOM) calls for a prompt action in Latvia that would decrease the negative influence of agriculture on the environment. Thus, the development of GAP Code is a part of the harmonisation of the Latvian legislation with both the EU legislation and HELCOM recommendations.

Similar Codes are developed and followed in the farming practice in all of the EU countries. In European context GAP Code is acknowledged as a statement of goodwill of each member state to follow the situation and development of its agriculture, to give priority to the preservation of the environment, and to cause no ecologically adverse consequences on national, regional, and global scale today and in future.

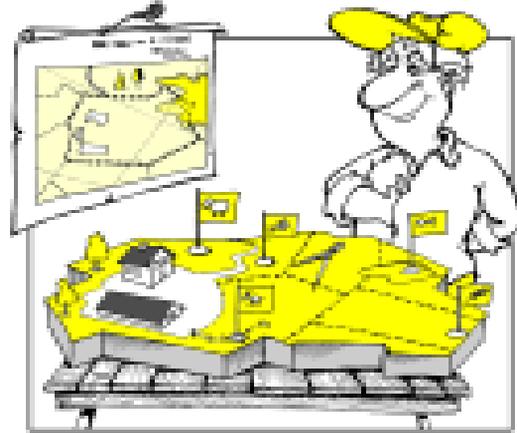
GAP Code contains requirements of three levels:

- existing legislation and regulations of the Republic of Latvia that are compulsory (**written in shadowed boxes**);
- regulations implemented in the nearest future (EU Directives, HELCOM Recommendations) that relate to actual agro-environmental problems;
- future aspects and visions that implemented today would give income in future.

GAP Code will be voluntary implemented by farmers based on the goodwill, the understanding and the desire to see their native country beautiful and prosperous today as well as in future.

1. CROPS, SOILS AND FERTILIZERS





1.1. PRODUCTION PROFILE AND LAND USE

Agricultural land is an important component of the environment and the natural landscape. Therefore, society has the right to monitor land use and conservation for the sake of the whole community. Law on Land Use and Land Use Planning (21.06.1991) is mandatory for all land users, including the farmers. Law demands responsibility for rational use of land in order to prevent its degradation and decrease in fertility.

1. The farming profile should be selected according to the soil and climate conditions for the specific area. It is a prerequisite for the economical development and reduction of the environmental risk.

Practical guidelines

In the process of the development of rational land use model for a farm it is necessary to consider the dominating relief, agroclimatic zone, soil cover, farm orientation against the watercourses, infrastructure elements, protective zones and zones of limited production activity as well as other natural landscape components. The land use planning should be based on the aforementioned information (same as previous). The planning includes the delineation of the fields and the assessment of suitability, e.g. for field crops, orchards, grasslands, pastures, forest, etc.

Special attention is required in the use of peatlands. Intent to include new peatland areas in agricultural production their drainage and cultivation probably is no more reasonable from the ecological point of view respecting wetland role in ecosystem as well as from economic considerations due to the necessity of substantial investment for that. In some cases exception could be made for high-decomposed muck soils. Protective measures should be applied in the cultivation of organic soils already used in agriculture to limit peat mineralization and structure breakdown. The main measures include a moderate use of mineral fertilizers (especially fertilizers containing nitrogen) and lime. It is as well important to cultivate perennial crops instead of annual ones. The best way for peatland use – cultivation of perennial grasses.

2. The production type, the farm layout, the development of infrastructure, and land use type shall be selected in accordance with the National Planning Strategy of Latvia and regulations on territory planning.

¹ Law on Territory Planning

The Territory Planning² is a State launched program that determines the territory zoning in accordance to accepted land use restrictions. It defines for what purposes and activities the specific territory is allowed (planned) to be used in future. Land and soil are essential factors that should be considered in the process of territory planning for setting objectives of a feasible use. Therefore, it is important to harmonise the interests of the individual land user and society to ensure a sustainable and balanced development of the country and its regions, as well as an integration of production activities with the protection and development of natural and cultural heritage.

3. Changes in the land use type shall be done with respect to interests of other land users to avoid negative impact on neighbours as well as on the whole ecosystem³.

The transformation of land use means a substitution of one land use type by another. It should be based on the considerations of ecological and natural landscape, not only on economic objectives. The land use in one farm shall not limit or restrict the neighbors from the use of their land:⁴

- construction of water ponds could stimulate the waterlogging of the surrounding areas that belong to other persons;
- a new forest plantation in a tile-drained field could damage the water management system and could create water-logging problems on large areas belonging to or being dependent on the specific drainage basin;
- defective water management systems can hinder drainage of neighboring fields.

Prime agricultural lands should be recognized to restrict their transformation in other land use types. These include high fertility and well cultivated areas where considerable state investment is made and areas that due to their location are particularly suitable for cultivation of some specific crops.

4. The basis for a sustainable cropping system is a well-developed crop rotation. The crop rotation should be planned to combine crops suitable for the specific soil type and should include considerations to minimize the risk for diseases.

Practical guidelines

Long term cultivation of crops without rotation (monoculture) results in the yield decrease, in the spread of weeds, pests, diseases, and in the depletion of soil productivity. Therefore, agronomically well-motivated crop rotation is an important factor in realization of economically and ecologically sound production. Despite this classical rule there is a growing tendency to use cash crops for a longer time during the last decade in Latvia.

Positive factors of the use of crop rotations in the context of production and environment protection:

- natural soil fertility is used more efficiently, need for less fertilizers;
- smaller pesticide requirement;
- elimination of the risk of soil erosion as well as of other possibilities of degradation;
- smaller possibility for nutrient leaching.

Some proportions between crops should be maintained, and succession of crops which promote the renewal of soil with others - which stimulates some depletion. In average these proportions should not

² Regulations of Council of Ministers No. 62 on Territory Planning

³ Regulations of Council of Ministers about Permits for Land Use Type Transformation

⁴ Code of Civil Law of Latvia

exceed the following values:

<input type="checkbox"/> sugar beet, fodder beet, potatoes	25 %
<input type="checkbox"/> legumes, flax	20 – 25 %
<input type="checkbox"/> rape	25 %
<input type="checkbox"/> wheat	33 %
<input type="checkbox"/> cereals, total	65 – 75 %

A crop rotation plan should be elaborated for every farm over 10 ha.

5. Crops or post-harvested residues should cover at least 50 % of the cultivated area to avoid or reduce the plant nutrient leaching and to minimise the risk for soil erosion.

Practical guidelines

For elimination of nutrient leaching (especially NNO_3) and erosion control it is important to keep a part of land covered by crops or plant residues in the late fall – winter period. The proportion of the so-called “green areas” and/or catch crops should be in a flat topography – at least 50 % of the cultivated land, but in a rolling topography where susceptibility to soil erosion is evident – 60 – 70 %. Crops that provide the functions of “the green cover” are following:

- winter cereals (wheat, rye, barley, triticale);
- winter rape;
- perennial grasses;
- perennial vegetables;
- fruit trees and shrubs, strawberry plantations.
- Crops that are harvested late can in some cases also fulfill the functions of “the green cover”:
- sugar beet;
- late harvested potatoes;
- corn for silage;
- late harvested vegetables (beet, carrots, cabbage, etc.).

Reduced leaching of plant nutrients can also be achieved if plant residues are left on the fields without incorporation into the soil, e.g. stubble, catch crop cover and sugar beet tops that are spread out evenly. However, the positive effect to avoid the leaching of plant nutrients is about only half as large in the case of “the green cover” crops and catch crops.

6. To avoid or reduce the plant nutrient leaching inter-crops are very recommended, especially on sandy soils, in the fields bordering with waters, in the case of intensive fertilizer use, and/or if the crop rotation is limited.

Practical guidelines

Catch crops are crops sown under the main crop or sown after harvesting of the main crop (stubble or winter after-crops) are used for forage or as a green manure for soil improvement. Thus, land can be used more intensively, the period of land covered by plants is extended, and the production of valuable forage or green manure is introduced. The plant nutrients left after the main crop are well used by catch crops and therefore leaching risk is prevented. It is very important to avoid the nitrate losses.

Table 1. Plants used as catch crop

Winter	Variation of catch crops	
	undersown	Spring stubble or winter aftercrops
Winter rye	Winter vetch	Winter and spring rape
Winter wheat	Annual ryegrass	Winter-cress
Winter triticale	Annual lupine	Oilseed rape
Winter vetch	Spring vetch	White mustard
Winter rape	Seradella	Phacelia
Perko	Sweet clover	Fodder lupine
	Clover	Annual ryegrass
		Leguminous and cruciferous plant mixture
		Seradella + annual ryegrass

Leguminous crops require that the following crop should be established very soon to avoid a loss of nitrogen due to leaching.

7. Soil degradation should be avoided and previously degraded land should be gradually recovered.

Soil degradation – human induced decrease of soil properties.

Rehabilitation measures of degraded soils are always much more complicated and expensive than preventive measures.

Practical guidelines

- Perform the soil cultivation in a way to reduce the risk of water erosion, e.g. by driving across the hillsides (slopes).
- Windbreaks (belts) should be planted in vulnerable areas.
- Choose a crop rotation plan that can minimise the risk for water and wind erosion in vulnerable areas. If erosion risk is large use overwintering crops.
- Make sure that pH is optimal for the specific soil type.
- Make sure the soil is dry enough to minimise the risk of damage from the heavy farm machinery.
- Make sure no pollution of chemicals occurs.

8. It is recommended for every commercial farm to elaborate a Project of Crop organization – a professional scheme of crop production in the farm that is based on detailed analysis of the specific site and conditions.

Every commercial farm (fertilized area more than 10 ha) should annually elaborate the Project of Crop organisation. It includes a professional assessment of local conditions and a compilation of a working plan for crop production.

Table 2. The main types of soil degradation

Type of degradation	Expression	Conductive factors	Prevention measures
Erosion, water	Translocation of soil particles by water. Fertile soil surface is removed, rills and gullies of different size are developed. At the same time outwash buries soil in other places. Pollution of waterbodies by soil particles and biogenic elements.	Land inclination, rainfall amount and intensity, soil type and texture, type of plant cover, soil tillage methods.	Afforestation of slopes if inclination > 20° (12°), crop rotations of perennial grasses dominating, special methods of soil tillage, fields covered by crops or stubble in the winter.
Erosion, wind	Translocation of soil particles by wind. Fertile soil surface is blown away. At the same time transported particles bury soil in other places. Pollution of waterbodies by soil particles and biogenic elements.	Soil texture (peat, sand), open landscape without natural barriers, type of plant cover, dominating direction and intensity of wind.	Shelterbelts, crop rotations of perennial grasses dominating, special methods of soil tillage, fields covered by crops or stubble in winter time.
Acidification	Lowering of soil reaction below the plant optimum.	Soil type, high concentration of certain compounds in precipitation, fertilizer use, low intensity of soil liming.	Soil liming.
Compaction	Compaction of soil surface and subsurface. Unfavorable conditions for plant growth and low water infiltration.	Use of heavy farm machinery when soil is wet, heavy textured soils low organic matter content, inadequate soil tillage, weak soil structure, intensive and unbalanced use of fertilizers.	Crop rotation, selection of soil tillage methods, liming and use of organic fertilizers for strengthening of soil structure, subsoiling.
Pollution	Accumulation of chemical compounds in soil harmful for plants, animals, humans.	Emissions from industry and transport, unauthorized use of sewage sludge, fertilizers, and pesticides.	Technology development for the reduction of emissions, use of sludge, fertilizers, and pesticides according to recommendations.

1.2. SOIL FERTILITY

Soil fertility is the scope of soil properties that ensure favourable growing conditions for plants. Important fertility parameters are factors such as soil type, texture and water regime, chemical (reaction, content of organic matter and plant available nutrients) and microbiological properties. It is possible to monitor all of these parameters and express them quantitatively. It is also possible to manage and achieve their improvement.



Following are some important practical guidelines for soil fertility control and management:

- it is a long and a time-consuming process to form favourable soil properties, therefore soil management is necessary to plan in a way that ensure gradual increase and stabilization of these soil properties. Soil depletion and the loss of fertility should be avoided;
- in the process of fertility management excessive and incompetent actions should be avoided to prevent a negative effect and environment pollution risk;
- some fertility parameters such as soil reaction and organic matter content are also of great ecological importance, therefore their optimisation is significant from the viewpoint of the environmental protection.

It is recommended to give priority to biological methods of soil fertility management such as:

- cultivation of catch crops, use of green manure;
- cultivation of leguminous crops;
- incorporation of straw;
- use of well prepared composts;
- soil liming.

Soil fertility is of important economical, ecological, and social concern. Only fertile soil is able to support a specific biodiversity of plant and animal species. It can be as a natural buffer and prevent plants from uptake of pollutants and limit their leaching in water. Fertile soil is essential for productive agriculture and sufficient income from farming as well as for maintenance of sustainable and balanced rural development.

Soil fertility is characterised and determined by several parameters. Most important parameters can be divided into three main groups:

- **soil physical properties.** Bulk density, structure, and soil moisture regime. These parameters are largely derived from the soil type, texture, and depth of groundwater as well as from soil tillage. These parameters are important to ensure formation of favourable water and air conditions in soil. They substantially affect other fertility factors.
- **agrochemical parameters.** Organic matter in soil, soil reaction, plant available nutrient status, cation exchange capacity, etc. These parameters determine other parameters and di-

rectly influence plant nutrient uptake. Although these parameters are partly derived from soil type and texture, they are more substantially influenced by soil management practice (soil liming, fertilizer use).

- **soil biological activity** depends on living organisms in soil (earthworms, worms, etc.), microorganisms (bacteria, fungi, etc.), and their activity. These organisms are able to affect the soil nutrient status and plant nutrient uptake. They facilitate breakdown of plant residues, mineralization of soil organic matter. They are responsible for synthesis and breakdown of harmful compounds, production of carbon dioxide (CO₂), etc. It is possible to manage the processes of microbiologic activity in agronomically favourable direction to some extent by means of the formation of other soil properties as well as by the use of fertilizers, especially organic ones.

9. The soil fertility should be maintained or improved by selection of suitable cultivation methods.

Practical guidelines

- pH should be maintained on the optimum level for the specific soil type. (See the table below).
- The content of nutrients in soil should be kept at the optimum level for the specific soil type. (See the table below).
- The biological activity should be considered as well as suitable crop rotation, fertilizing, etc.
- Pollution created through expedient practices should be avoided.
- The bulk density of mineral soil should be suitable. (See the table below).

10. Soil testing is recommended at least once in 5 years in order to obtain a reliable information about soil fertility status and necessary improvements.

Practical guidelines

The basic soil agrochemical parameters are soil reaction, organic matter content, plant available phosphorous, potassium, and magnesium content in soil. In general these parameters give the necessary information about the productivity of the arable land, orchards, pastures, and grasslands. On the basis of these parameters it is possible to plan soil liming, fertilizer use and other soil improvements. Several other soil parameters should be also assessed only if some specific crops will be cultivated. For example, vegetables, oil crops, potatoes and other crops with high calcium, sulfur, and micronutrient requirement. Such analyses are quite expensive, and an experienced expert is only able to provide interpretations of the obtained results. Therefore, it is reasonable to contact your adviser and discuss the necessity for parameters and the possible use of the results before ordering an analysis from the laboratory.

The soil testing process should be divided in three stages to obtain the high quality results. All of them are very important and should be completed accurately:

- delineation of expected soil sampling places on the field, sampling, sample preparation and sending to the laboratory;
- analytical procedures to assess the necessary parameters;
- data interpretation and planning of soil improvements.

Soil sampling should be done preferably in fall or early spring, when fields are not sown and not recently limed or fertilized. At that time it is possible to reach the soil differences more accurately and to avoid liming and fertilization interference. The results will be already available for the coming farming

season. It is recommended to do the soil sampling at the same spots and during the same season as it was done previously.

The optimal plant nutrient concentrations in soil, soil reaction as well as other physical and chemical properties that are important to provide the best possible growing conditions for crops and minimal environmental risk depend on soil type and textural class.

The values of optimal soil parameters can be found in the professional literature (reference books, norms, etc.). Some aspects of the positive influence of organic matter content on soil's agroecological status

- stabilization of soil moisture status, soil structure;
- reduction of bulk density;
- reduction of plant nutrient leaching from the root zone;
- stimulation of soil's biological activity that facilitate the plant nutrient uptake and the breakdown of used pesticides;
- reduction of harmful compound (heavy metals, pesticide residues, etc.) mobility in soil.

Some examples of the positive influence of soil reaction (optimum – around neutral) on its agroecological status

- stimulation of well developed plant cover;
- stimulation of agronomically desirable soil structure development;
- intensification of soils' microbiological activity;
- reduction of harmful compound (heavy metals, pesticide residues, etc.) mobility in soil, etc.

Excessive plant nutrient concentrations in soil should be avoided. Otherwise, nutrient loss and environment pollution risk increases. Especially it is important in the case of mineral nitrogen concentration in soil after harvesting of crops in fall, because mineral nitrogen could be easily leached out. Therefore, it is recommended to carry out soil sampling periodically to avoid development of such unfavorable situations, and to adjust the nutrient status in the soil according to the crop plant nutrient requirements.

The following table gives an example of optimal agrochemical parameters for soils of arable land, pastures and grasslands. These values are different for several specific crops like vegetables, ornamentals, orchards, and plants cultivated in greenhouses.

Table 3. Optimal soil fertility parameters

Author: RAZIBA

Parameter	Organic matter content, %								
	< 5,1				5,1 – 20,0				> 20,0
	Soil texture								
	C	L	SL	S	C	L	SL	S	P*
pH KCl	6,6-7,3	6,4-7,0	5,9-6,5	5,6-6,1	6,3-7,2	6,0-6,7	5,7-6,3	5,4-5,9	5,1-5,6
P ₂ O ₅ , mg/kg	160-220	130-190	120-180	100-160	200-260	190-250	180-240	160-220	320-380
K ₂ O, mg/kg	200-260	180-240	160-200	100-150	300-360	280-340	260-320	200-250	440-480
Org. matter, %	3,0-3,5	2,5-3,0	2,0-2,5	1,5-2,0	No values for these soils				

*Soil texture: C – clay, L – loam, SL – sandy loam, S – sand, P – peat

Table 4. Parameters of bulk density of mineral soil (OM < 5 %)

Authors: A. Vucans, I. Gerste

Interpretation	Bulk density, t/m ³	
	surface layer	subsurface layer
Suitable	< 1,40	< 1,60
Partly compacted	1,41 – 1,50	1,61 – 1,70
Critical	> 1,50	> 1,70

Overliming of soil should also be avoided, especially in the case of organic soils and peatlands. It accelerates the mineralization of organic matter and has a negative impact on some soil properties as well as on availability of several nutrients, especially micronutrients, for plants.

11. Fixation of atmospheric nitrogen by soil microorganisms is considered a desirable and facilitated process in agriculture. However, accumulation of great amount of nitrogen rich and readily mineralised organic compounds increase environmental risk due to the potential leaching of released mineral nitrogen compounds.

Practical guidelines

Leguminous crop cultivation improves soil's physical properties and has a positive effect on soil's microbiological activity. Due to a symbiosis between legumes and microorganisms a considerable amount of atmospheric nitrogen is fixed. Fixed nitrogen is consumed by legumes and is also left in soil for the following crop. However, compounds containing nitrogen are mineralized quite fast in soil after extermination of leguminous crop cover, e.g. after plowing. Thus, a considerable amount of nitrogen can be lost due to the leaching if the following crop is not planted immediately. Therefore, the time period between soil plowing and planting of the next crop should be as short as possible. It is especially important for sandy soils.



1.3. SOIL TILLAGE

Soil tillage is one of the basic activities in crop cultivation and is usually combined with the incorporation of post-harvest plant residues, organic and mineral fertilizers and sometimes also of pesticide into soil. It is important to consider sequence and interaction in the planning of soil tillage methods for certain crop cultivation. In other words, it is necessary to consider what activities have been already carried out in the cultivation of previous crops, what are expected actions in the cultivation of the following crop, what agrotechnics will be used, and what are other soil conditions (weeds, phytosanitary situation, etc.) all together.

It is important that the soil tillage planning should have a future oriented perspective considering at least next 2 – 3 years. Soil tillage affects soil physical parameters and has an important influence on the soil environment in general including the plant nutrient bioavailability, processes of nitrogen turnover in soil (ammonification, nitrification, denitrification), microorganisms responsible for plant diseases, etc.

12. Soil tillage should provide the optimal conditions for crop growth. It should be carried out as often as necessary, and simultaneously its intensity should be as little as possible.

Soil tillage – mechanical manipulations performed by means of different tools and implements. Thus, there is a close relationship between soil tillage and other practices used in crop cultivation, that provide and optimize the appropriate conditions for plant growth, maintain and improve soil fertility, control weeds and diseases, economizes resources in crop production as well as retain the quality of the environment.

Practical guidelines

Carry out ploughing and harrowing when the conditions are optimal, i.e. when the soil humidity is appropriate to achieve good results:

- after ploughing plant residues and weeds should be covered;
- ploughing should be done thoroughly. Thus, you spare unnecessary harrowing to prepare a good seed bed;
- the harrowing should not be deeper than necessary to get a good seed bed.

13. Soil tillage should ensure an economy of energy, costs, and resources as well as preservation of soil and nature.

Practical guidelines

There are several soil tillage methods. Each of them has its own specific main objective: plowing, cultivation, harrowing, dragging, stubble plowing, rotary tillage, and rolling. The following factors are considered in the selection of the most suitable tillage method:

- field conditions after harvesting of the forecrop;
- soil type, texture, and physical properties;
- requirements of the succeeding plants;
- soil tillage equipment to be used;
- weather conditions;
- length of the period between forecrop harvest and optimal date for sowing (planting) of the succeeding crop;
- field topography, stoniness, etc.

Additionally, soil tillage methods should be adjusted according to what is protected or prevented, e.g. certain weed control, the destruction of soil crust, the soil water accumulation, the soil loosening or packing, etc. It is also important to adjust the tillage operation span with the power of the tractor used. It is recommended to combine different tillage operations and to use complex agricultural machinery that provides soil tillage and plant seeding simultaneously.

The basic method of soil tillage is plowing with share plough. The use of this implement ensures turning and mixing of plant residues, mineral and organic fertilizers with the soil. The following aspects should be considered for better results:

- the best plowing tool is a reversible plough that leaves no furrows on the field;
- plowing course depends on the field relief (see *erosion*) and on the way the crops would be sown (across the plowing direction). It is recommended to do plowing across the direction of the drainage lines not parallel to them;
- the plowing depth should be adjusted according to the depth of arable (organic) soil horizon and crops expected to be grown. The plowing depth can be classified as follows
 - stubble plowing – up to 10 cm,
 - shallow plowing – 10 – 20 cm,
 - regular plowing – 20 – 25 cm,
 - deep plowing (subsoiling) – more than 25 cm;
- the effect of the plowing depends on the shape of the mouldboard, soil humidity, and on the width and speed of the tillage operation. It is very important to do plowing at optimum soil humidity;
- it is recommended to change the plowing depth periodically to avoid the formation of compacted soil layer – plough pan. It limits water movement and root growth. Deep plowing (subsoiling) should be combined with the use of organic fertilizers;
- frequent plowing speeds up mineralization of soil organic matter, reduce the humus content, and can therefore induce decline in the physical, chemical and biological properties of soil;
- undesirable effects of plowing can be avoided by a use of tools that do not turn around the soil, such as cultivators, dicks, rotation harrows, as well as special non-turning plows.

If the soil is too loose, it is necessary to compact it on the surface or subsurface. Different kinds of rollers are used for this purpose such as flat and crumble ring rollers, roller tillers, and subsoil plotters. If possible, the number and the depth of agricultural treatments should be limited by combination of tools, so that they would not overcrush the soil.

14. Soil tillage practices should be realised in definite agronomically well-grounded succession. The best effect is reached if the practices complement each other. It is called the soil tillage system that properly selected and realized is an essential prerequisite for sustainable development of crop production.

There is no particular soil tillage method that would be the best for all circumstances. In crop rotation with sequence of plants it is always necessary to choose the most appropriate method, to fix the tillage depth and other parameters depending on the particular requirements of each crop. Every single soil tillage treatment is not able to provide the appropriate growing conditions for crops, therefore a soil tillage system should be elaborated. Soil tillage systems can be classified according to crops they are recommended for (spring cereals, winter cereals, potatoes, etc.) and as systems for some specific aim (for eroded and susceptible of erosion soils, for peatlands, for irrigated land, conservation tillage, minimum tillage, etc.).

15. The time of soil tillage is an important factor for the formation of good soil properties, as well as to ensure the necessary work quality and soil conservation. The tillage conducted too early, or on the opposite, too late (particularly in clayey soils) could cause rather negative after-effect on the further work and plant growth.

The soil tillage should be performed when soil is ready, i.e. when it has optimum humidity, crushes easily, does not stick to tillage tools, and tillage operation can be performed with minimum force. Soil humidity is a main factor affecting these properties. The optimum humidity depends on soil texture and could be as following: for heavy textured soils (clay, loam) 50 – 60 %, coarse textured (sandy loam, sand) 40 – 70 % of the full water capacity. The negative effects of soil tillage done in the wrong time are compaction, overcrushing, and structure degradation.

Practical guidelines

Soil readiness for tillage can be checked using the following simple method. Take a clump of soil, roll it between your hands, and let it to fall down. The soil is ready for tillage, if the clump breaks down in fragments. The soil is too wet, if it keeps together. The soil is too dry, if it is impossible to form a compact clump by hands.

16. Soil erosion – the process of degradation, translocation and deposition of surface soil particles. It is caused and accelerated by an improper land use. Therefore, the farming practice should be in compliance with measures that provide gradual recovery of degraded soils instead of stimulating erosion.

Soil erosion – translocation of soil surface particles as a result of water, wind or, in many cases, of the human activities.

Water erosion. Water erosion causes deterioration of both soil surface and its deeper horizons, and it stimulates leaching of plant nutrients into the surface waters. If it is very intensive, the characteristic pattern of sheet, ridge, and gully erosion develops. As a result water is polluted by biogenic elements, and a particularly negative effect is caused by nitrogen and phosphorus.

Table 5. Classification of soil affected by water erosion

Erosion class	Slope (degrees)	Characteristic pattern
No erosion	0 – 5°	No significant movement of topsoil by water action.
Slight to medium	6 – 10°	Some loss of A horizon and part of the B horizon is mixed by plowing.
Medium to strong	11 – 18°	Loss of A and partly B horizons, C horizon is partly mixed by plowing.
Strong	< 18°	All genetic soil horizons are lost. C horizon is exposed.

The amount and intensity of precipitation, depth of snow cover and its melting intensity, land inclination, soil type and texture, plant cover are the main factors responsible for the development of soil erosion and its intensity. On the farm level main erosion control measures include appropriate crop rotation, soil tillage methods as well as other anti-erosion practices.

Table 6. Soil susceptibility to water erosion

Susceptibility class	Characteristic pattern
Highly susceptible	Silty soil material, loess
Very susceptible	Loose fine sand, rendzina
Medium susceptible	Gravel, medium sandy
Low susceptible	Coarse texture, including sandy loam
Resistant	Loam, soil rich with coarse fragments

17. Crop production pattern and tillage system should be selected according to the local conditions to keep down water erosion of soil.

Practical guidelines

Normal crop rotations are used in the fields with inclination of up to 6°. In the fields with inclination 7–14° special anti-erosion measures should be undertaken: appropriate crop rotations and tillage operations, etc. The row crops are recommended for cultivation in the fields with inclination not exceeding 10°, and rows should be across the slope. If fields have inclination of 15–20°, permanent plant cover (sod) should be kept or afforestation performed. Fields with inclination exceeding 20° should be afforested. Anti-erosion crop rotations must consist mainly of leguminous plants, their mixtures with grasses, and winter crops. Winter rye, wheat, rape, and triticale are highly recommended, because they form a compact cover in the fall.

In crop rotations with the forecrop harvested early and the next crop introduced in spring, it is important to cultivate stubble or winter aftercrops. Stubble crops remain plowless for winter forming mulch. Unown areas should be covered for winter with different mulching materials such as straw, stalks, and leaves.

All agricultural treatments including sowing or planting should be done across the slope. Use of reversible plough is recommended because it turns the ridge to the top of the slope. Such operation can be performed with the regular plough if inclination of slope does not exceed 5–8°.

All kinds of soil located on steep slopes must not be plowed. They should be tilled without turning the soil. Special wide spike-tooth (duckfoot) cultivators could be used. Presowing tillage with passive tool set

consisting of harrow or cultivator with cage or subsurface roller could be also used. Cultivation of cereals and leguminous crops by using direct sowing with special drill is recommended in appropriate conditions.

Special anti-erosion treatments should be applied on soils very susceptible to erosion, e.g. furrowing, mole draining, subsoiling, dibbling, etc. Furrowing consists of digging or ridging either continuous or broken furrows across the slope. Furrows are supposed to scatter and limit water run-off and to increase retention of water in soil. Mole draining includes drilling under the soil surface in the depth of 40 – 50 cm. It creates a system of continuous or broken canals of approximately 5 – 10 cm in diameter and directed across the slope. Mole drains are made by a special tool – mole plough. It increases soil water retention and reduce the amount of water flowing down the slope.

Subsoiling includes soil vertical cutting for the increase of water retention and water soaking into soil's deeper layers. It is done by a special tool – subsoil plough or regular ploughs if the mouldboard is removed.

Land of rather flat slopes inclined up to 6° is less susceptible and affected by water erosion especially if slopes are long. However, it is advisable to cultivate across the slope. Gullies on the fields should be leveled out in order to prevent their further development.

18. Several regions of Latvia with open landscape, large fields and sandy soils dominating are affected by wind erosion. This factor should be considered in the selection of soil tillage system.

Wind erosion. Wind erosion is especially harmful to the surface layer of the soil (it is blown away), to the plants (mechanical damage), to the root system (it is uncovered), and also to the environment in general (dust pollution).

Intensity of wind erosion depends on soil conditions (texture, moisture regime), wind speed and periods of its appearance, field size and landscape diversity, and plant cover. Wind erosion causes the greatest damage agricultural areas with plain and open landscape, if soil is dry, soil's texture is sand or peat, and large fields dominate with no natural barriers like forests, trees, etc. Crop damage occurs most frequently in early spring.

Table 7. Soil susceptibility to wind erosion

Susceptibility class	Characteristic pattern
Highly susceptible	Loose sand, peat land under cultivation
Very susceptible	Consolidated sand, loess
Medium susceptible	Sandy loam, light silt loam
Low susceptible	Silt loam
Resistant	Loam, clay

Practical guidelines

Obviously, the most effective treatments to prevent soil from wind erosion are shelterbelts consisting of trees and bushes, and fields kept with plant cover as long as possible. Crop rotations should mostly consist, if possible, of perennial grasses and winter crops (cereals and rape) because they form good and stable plant cover already in the early fall.

It is advisable to include some aftercrops in the crop rotation of winter cereals – spring cereals or to leave some mulch (straw, stubble, and leaves) for the winter period. In areas heavily threatened by wind erosion soil tillage should be done without turning soil, and plants ought to be sown directly into the stubble of the previous crop. Trees should be planted on sand dunes created by wind in the farmland.



1.4. FERTILIZER USE

Use of organic and mineral fertilizers is an effective tool for soil fertility management and crop production. The agriculture as a whole and crop production particularly depends on fertilizers. Fertilization is also important for economic considerations of agriculture as well as for the formation of high quality agricultural products. Like other agrotechnical treatments fertilization should follow certain rules and criteria. All excessive and agronomically not motivated actions must be avoided. Otherwise fertilization could cause only losses not only for the farmer but also for the environment and the whole society (economic and ecological).

19. Production of a high yield of good quality should be reached through a use of a balanced and sufficient fertilization with organic as well as mineral fertilizers. The fertilization should correspond to the nutrient requirements of crops and sustain an optimal soil fertility with a minimum pollution of the environment.

The influence of fertilizers on the environment can be characterized from two aspects:

- **positive effect** – due to fertilization crop yields increase and quality improves, thus stimulating the well being of society. Photosynthetic intensity raises. Absorption of CO₂ and refinement of atmosphere from other harmful compounds increases;
- **negative effect** – environment pollution with biochemically active compounds, disturbance of natural equilibrium in ecosystems that eventually unfavorably affects their further functioning. Environment pollution risk mostly exists due to neglect of agronomic rules, careless actions, lack of knowledge, etc. Some examples how the undesirable impact of fertilization is caused:
 - if rules of transportation, storage, and application of fertilizers are neglected;
 - plant nutrient losses from soil due to leaching, erosion and surface run-off, emissions into atmosphere. Plant nutrient leaching from soil root zone is very influenced by soil's reaction. Leaching is more intensive if soil is acid, therefore soil liming also has an ecological importance. Heavy metals and radionuclides are also more mobile in acid soils, therefore their uptake by plants could increase;
 - environment pollution with elements that are contained in fertilizers – Cl, Cd, Rb, As, U, etc. For example, phosphorus fertilizers contain 0.5 – 5.0 % fluorine. Fluorine compounds are able to move around in the soil profile and to accumulate in plants, especially potatoes. Phosphorus fertilizers also contain a particular amount of cadmium and strontium. Use of communal and industrial wastes as fertilizers that contain undesirable elements;
 - concentration of some compounds in crop products that could be harmful for product consumers – humans and farm animals: nitrates, nitrites, potassium, etc.

20. All of the produced organic fertilizers, e.g. farmyard manure, slurry, animal urine etc., should be used as fertilizers on the fields. Spreading should be done to ensure the highest possible utilization of plant nutrients and the least possible loss to the environment.

Farm animals use and retain in their body for physiological requirements, including the production of milk, meat, wool, eggs, etc., only a small part of nutrients taken in with forage. The main amount of consumed feed, approximately 50 % of dry matter, 70 – 80 % of nitrogen, 80 % phosphorous and 95 % potassium are excreted from organism with urine and faeces. Thus, this amount is contained in manure. If animal urine and feces are collected, litter added, stored, and returned back on the fields, a considerable amount of plant nutrients will be reverted in soil. Thus, economic benefit for farm is achieved. If such actions are not undertaken, animal production becomes a serious source of environment pollution. It is because a huge amount of chemically and biologically active compounds concentrate around the animal housing units, and leakage to surface or groundwater, wells and other places would always happen. It will cause anti-sanitary conditions around the area; especially if manure storage does not correspond to the environment protection requirements.

The positive effects of manure, except aforementioned, are manifold:

- manure is active in soil humus formation;
- intensification of soil microbiological activity;
- production of carbon dioxide, biologically active compounds, enzymes, vitamins;
- improvement of soil physical properties.

It is necessary to consider particular specifics of manure in the planning of its use. In manure plant nutrients are mainly in the organic compounds and therefore available for plant uptake after their mineralisation. Rate of mineralization varies for different kinds of manure, for example:

- urine, slurry – very fast mineralization, quick effect on plant growth, however the influence on soil humus formation is weak;
- straw, manure with straw litter – slow mineralization and plant nutrient release, nevertheless an important role in the soil humus formation.

Rational accumulation and use of organic fertilizers are important for all farms notwithstanding of their specialization. Agronomically recommended intensity of organic fertilizer use is 15 t/ha annually, if calculation is based on farmyard manure with 20 % of dry matter. Mainly it depends on balance between crop production and animal farming in the farm. If the animal production is dominating, the problems with ecologically safe manure utilization will exist. If the plant production is dominating, it will be difficult to keep a positive humus balance in soil. Therefore, the optimum between the two farming branches should be about one animal unit per hectare of cultivated land, not exceeding 1.7 per hectare. It could slightly differ depending on crop rotations

In general the number of different kinds of organic fertilizers is quite large. In Latvia the most often used fertilizers are following: farmyard manure, slurry (liquid manure), urine, poultry manure, composts, communal and industry wastes, sewage sludge, green manure, straw, spropel, and other organic materials.

21. The amount of organic fertilizers that could be produced in a farm depends on several factors. It is important to know and consider different possibilities before decision making and planning of future activities.

The amount of possible manure accumulation in a farm depends on the following:

- kind of animals and their age;
- forage and feed used;
- duration of period when animals are in barn;
- animal housing system, technology used for manure collection;
- litter used in barn (kind and quantity);
- water added to remove liquid manure;
- manure storage duration and conditions, i.e. the amount of manure left after storage.

22. Application rates should be based on plant nutrient content in manure.

Therefore, determination of chemical composition of manure produced in a farm is essential precondition for its agronomically and economically sound use. The total amount of nitrogen applied with farmyard manure, slurry or animal urine must not exceed 170 kg/ha annually.

Chemical composition of manure (plant nutrient content) depends on the following:

- kind of animals;
- forage and feed used, feeding system;
- duration and conditions of manure storage;
- litter added to manure;
- water added to liquid manure.

Practical guidelines

It is recommended to take samples and send them for analysis periodically to ensure the quality of manure (plant nutrient content) accumulated in farm. If analytical data is not available, special normatives should be used that determine the average data.

Application rates for farmyard manure and slurry (liquid manure) must be fixed based on **nitrogen** and **phosphorus** content and their utilization intensity. It is not allowed to exceed the application rates behind the agronomically and environmentally grounded limits.

The amount of manure available for fertilizing is calculated for the whole year (365 days). Some animals might be kept outside the barn. In this case manure accumulation as shown in this table should be corrected taking into the consideration so called inborn period. Commonly, it is as following (days):

<input type="checkbox"/> milking cows	220
<input type="checkbox"/> heifers	220
<input type="checkbox"/> beef cattle	180
<input type="checkbox"/> horses	180
<input type="checkbox"/> sheep	210

Other kinds of livestock usually are inborn over the whole year.

Data about the amount and chemical composition of manure in farm might differ from those listed in normatives depending on particular feeding system, litter used, technology of manure handling, duration and conditions of storage. Manure analysis is recommended to adjust these differences periodically.

Farmyard manure should be used as a fertilizer sufficiently soon after it is produced. It should not be stored for several years on fields or in storage places before spreading.

Table 8. Draft manure normatives for Latvia*
(per one animal after storage)

Housing system	Manure type	Tons per year	Dry matter, %	Content, kg per ton of manure		
				N	P ₂ O ₅	K ₂ O
Sow with 18 piglets to 20 kg weight						
Solid floor	Solid manure	4,6	28	4,6	3,5	3,6
Slaughter pig , 20 – 100 kg live weight						
	Slurry					
Slotted floor	•washing	8,7	3	1,2	0,6	1,0
	•periodical flush	3,4	6	2,7	1,6	3,8
Solid floor	Slurry	3,6	6	3,3	1,6	2,8
	Solid manure	2,6	20	5,7	3,2	6,0
Dairy cow , milk yield 3500 – 5000 kg per year						
Tie up, solid floor	Solid manure	13,0	22	4,8	1,9	4,0
	Slurry	22,0	7	2,3	0,9	1,9
Dairy cow , milk yield 5000 – 7000 kg per year						
Tie up, solid floor	Solid manure	15,5	22	5,4	2,2	4,2
	Slurry	27,0	7	2,4	1,2	2,2
Dairy cow , milk yield above 7000 kg per year						
Tie up, solid floor	Solid manure	17,5	22	5,5	2,3	4,4
	Slurry	30,0	8	2,6	1,4	2,4
Young stock (cattle), up to 6 month old						
Tie up, solid floor	Solid manure	2,6	21	5,5	2,1	4,5
	Slurry	6,0	7	1,9	0,8	1,5
Tie up, deep litter	Solid manure	4,0	25	4,5	1,9	3,8
Heifer , 6 to 24 month						
Tie up, solid floor	Solid manure	6,7	21	5,5	2,1	4,5
	Slurry	15,0	7	2,2	0,9	1,8
Tie up, deep litter	Solid manure	9,0	25	4,6	1,9	4,1
Bull , from 6 months up to 450 kg live weight (26 months)						
Tie up, solid floor	Solid manure	11,1	21	4,7	1,9	4,2
	Slurry	20,5	7	2,2	0,9	1,8
Slotted floor	Slurry	20,5	7	2,2	0,9	1,8
Free, deep litter	Solid manure	15,0	25	4,2	1,8	4,6
Horse						
Solid floor	Solid manure	8,0	31	5,2	3,6	7,5
Sheep						
Deep litter	Solid manure	0,9	29	7,8	4,7	10,5
Hens						
Deep litter	Solid manure	0,1	44	17,2	12,4	8,2
Battery	Slurry	0,1	15	10,6	7,2	3,8

*The figures in Table 8 are based on qualified estimates. On basis of this data the calculation of fertilizer plans, manure storage capacity and livestock units could be performed. Further research will provide redefined and validated figures, and an updated manure standard.

23. Manure should be spread on fields in periods that correspond to the maximum nutrient need by crops. Uniformity of application should be ensured, and manure incorporation in soil should be as fast as possible.

Plant nutrients in farmyard manure, slurry, and urine form soluble compounds. Nitrogen can easily evaporate in the form of ammonia. Therefore, considerable nutrient losses can happen that reduce the manure fertilizer value and lead to serious environment pollution. It should be used for the crops that utilize the nutrients most efficiently. Manure, slurry, and urine should be used in periods when crops can intensively uptake nitrogen. Only farmyard manure rich in litter and used only on heavy textured soils (clay, loam) is allowed to be spread out in the fall for crops sown in the next spring.

24. Farmyard manure, slurry and animal urine must not be used in winter time and early spring between October 15 and March 15, when their incorporation in the soil is impossible. Besides, it is prohibited on the frozen, water saturated, flooded, and snow covered soil.

Practical guidelines

Some recommendations important for manure use.

- Manure, slurry, and urine after their application should be incorporated into the soil to avoid the nitrogen losses. Incorporation should be done as soon as possible but not later than following: for farmyard manure – on the day of application, for slurry and urine – within 5 hours after application.
- Organic fertilizers for grasslands and pastures should be applied in early spring when the weather is chilly and humid. It is advisable to do grassland harrowing after the fertilizer application.
- Slurry and urine can also be spread out on the growing plants. If so fertilizer incorporation in soil should be provided or, alternatively, fertilizers should be placed directly on the soil surface in a form of concentrated bands or shallow ridges between the crop rows. In this case a trailing hose system or injection system should be used.
- The best way of urine utilization is its use in compost preparation, thus to avoid the plant nutrient losses.

25. Farmyard manure, slurry, and animal urine should be used in fields with slope exceeding 10° only if the fields are covered by plants or if fertilizers are directly incorporated into soil.

Farmyard manure, slurry, urine must not be applied closer than 10 meters from the coast line of waters (lakes, rivers, ponds), drainage channels, wells and other sources of water.

26. All available sources of organic manure should be used in a farm to sustain soil fertility, recycling of plant nutrients, and utilization of production and household wastes. It should be in accordance with sanitary requirements and environmental regulations, and it must not have a harmful effect on the quality of the environment.

Practical guidelines

Characterisation of most common organic fertilizers used in Latvia.

☐ **farmyard manure** - excreta from farm animals (cattle, pigs, horses, sheep, etc.) together with bedding material (straw, peat, and sawmill dust);

☐ **slurry (Liquid manure)** - excreta from cattle or pigs, that are removed from manure channels by water and therefore diluted to some extent and containing no litter;

☐ **urine** - liquid excreta from cattle or pigs;

☐ **poultry manure** - accumulated with litter or in the liquid form (slurry). Contains more plant nutrients compared with the manure from other kind of animals;

☐ **composts** - organic material admixture of different origin (manure, urine, peat, wastes, plant residues, etc.) that has been biologically treated in the process of composting. In the process of composting different materials that can not be used as fertilizers directly or that contain some harmful compounds are biologically converted into the valuable plant nutrient source. For example, communal and industry wastes, sawmill dust, straw, etc;

☐ **green manure** - crops grown for use of soil improvement;

☐ **straw** - after harvesting of crops the straw is left on the field, chopped, added some extra nitrogen (20 - 30 kg/ha or 10 kg per ton of straw), and incorporated into the soil;

☐ **sapropel** - fresh water sediments (lakes, ponds). Used directly or after composting;

☐ **wood industry wastes** - sawmill dust, wood processing wastes, etc. Chemical composition differs greatly, however generally low in nitrogen. Considerable part of organic matter in a form of hard degradable compounds: cellulose, lignin, resins, etc. Requires long composting that exceeds one year. Compost components might be slurry, urine, poultry manure, communal wastes, industry wastes and other materials rich in nitrogen, as well as nitrogen fertilizers. It should be noted that composts not yet ready may contain compounds harmful for plants;

☐ **other organic materials** - sugar beet tops, leaves, plant residues, seaweeds, etc.

☐ **communal and industry wastes, wastewater** - wastes from communal sewage units, food industry (fermentation, sugar refinery, starch, meat processing, dairy, fish, fruit, vegetables processing plants), hydrolysis, pharmacy, textile, leather industries. These wastes that could be used for soil improvement, might be classified as follows

☐ wastes that could be used but only after control of harmful substances in them;

☐ wastes that should be composted before use;

☐ wastes that should be plowed down some period beforehand the crops are grown;

☐ wastes that should be used without any special limitations.

Composting must be done for wastes that could contain sources of infection, helminthes, plant pests or diseases. Such kinds of wastes come from slaughterhouses, feather and fur processing plants as well as from vegetable and fruit processing. Wastes containing low amount of easily available nitrogen and plenty of carbon should be used some period before crop growth. For example, wool and flax fiber processing wastes, because some time is necessary for microorganisms to start the process of decomposition. No special limitations are necessary for the use of wastes that mineralisation in soil is fast and that contain no dangerous organisms. This group includes some wastes from food industry,

wastes from fish processing, dried meat and blood meal, hoof and horn meal, tobacco dust, wastes from alcohol distilleries, starch production etc. Wastes from alcohol distilleries contain more dry matter and depending on composition they could be used on the fields without crops, they could be used diluted for crop top-dressing or to make composts after separation of the solid phase. In some cases if wastes are not suitable for agriculture, they are acceptable for forest fertilization.

Before use of aforementioned wastes as soil conditioners or fertilizers special attention should be paid to possible requirements and limitations that are included in different legislative documents. Particularly it is important in the use of sewage sludge (see *hereafter*).

27. Mineral fertilizers are highly active materials. Their rational use gives possibility for fast increase in crops' yield and quality, build-up of soil fertility and, finally, farm economy in general. However, incorrect use causes undesirable effect on soil and crops as well as environmental pollution.

The use of mineral fertilizers is an essential prerequisite for high yield production because there are not enough plant nutrients in Latvian soils to provide crops within the rather short plant-growing period. Rather high investments are needed for fertilization for quite a long period. Therefore, sound economic assessment is necessary before decisions are taken, and all activities should be done considering agronomical conditions. It should be emphasised that non-renewable natural resources (phosphate, potassium-containing minerals, natural gas, energy) are used in the production of mineral fertilizers, and their deposits on the earth are limited. Improper use of fertilizers can create serious environment pollution because well soluble, biochemically active (biogenic) compounds can reach the surface and groundwater. Therefore, rational use of fertilizers is important for both agronomic and environmental aspects.

28. The most appropriate kind of fertilizers should be selected for the specific situation. It gives the possibility to reach the maximum positive response with minimum undesirable by-effects.

Practical guidelines

Nowadays assortment of fertilizers is very multifarious. The following main considerations might be used in the decision making about the best kind of fertilizers in the specific situation:

- production conditions (soil, weather within the growing season, agrotechnics used, kinds of crops and purpose of their growth, etc.). The excessive use of nutrients should be avoided, that is particularly probable when multinutrient fertilizers are applied;
- undesirable elements could be contained in the fertilizers. It is necessary to evaluate the response of plants on their presence. For example, chlorine in potassium fertilizers and ammonium chloride, excess sodium in sodium nitrate, as well as smaller amounts of other elements. Phosphorous fertilizers contain a small amount of cadmium as well as other heavy metals;
- economical considerations. In the given situation not only the most suitable but also the cheapest kind of fertilizers should be selected and applied using the best available technology.

29. Fertilizers should be kept in original packages and in conditions that are required for their storage.

Practical guidelines

There exist special guidelines and regulations for fertilizer storage and handling that take into account physical and chemical properties of fertilizers, their possible negative impact on the environment, hazard risk. One group of regulations is managerial, the other is technical regarding buildings and equipment used for fertilizer handling. The main principles that should be considered in fertilizer storage are as follows:

- orientation of fertilizer warehouses respecting other buildings and constructions;
- prevention of storage places from moisture;
- fire-safety regulations;
- fertilizer loading height;
- fertilizer batch, identification, labelling;
- storage capacities for liquid fertilizers:
 - allowed load and volume for vassals,
 - leak and pressure proof,
 - marking of vassals,
 - pressure gauges,
 - earthwork that twines the storage;
- allowed period of storage;
- corrosion prevention;
- environment protection rules.

30. Fertilizer application rate should be determined based on plant nutrient requirements to achieve the estimated yield level, and adjusted according to the plant available nutrient content in soil and organic fertilizers applied.

Practical guidelines

Determination of fertilization rates is very responsible and quite complicated task.

- Fertilizer rate should be agronomically well-grounded. If low it is hard to achieve planned (feasible) crop yield. If too high – an undesirable effect might be caused (environment pollution, crop lodging, loss of yield quality, etc.). Therefore, soil should be tested periodically to adjust the fertilizer rate.
- Plant nutrients in fertilizers should be well balanced. Deficiency or excess of a certain plant nutrient will cause a negative effect.
- The followed practices should be focussed on a goal to facilitate mobilization of plant nutrients in soil in an easily available form when their uptake by plants reaches maximum. It is particularly important for nitrogen because of its high mobility in a soil. Excess nitrogen not used by plants can easily be leached out from the root zone. Therefore, it is common to split and apply the total nitrogen necessary in several treatments.
- Fertilizers can never cover mistakes and inaccuracies that are made in other operations during crop growing. Reasonable crop rotation, high quality soil tillage, healthy seed, weed and disease control, optimum soil moisture regime, soil reaction, rational use of organic fertilizers, etc.

– all together are a necessary background for excellent fertilizer performance.

- The plant nutrient diagnosis is a special tool that, might be very useful for adjustment of fixed fertilizer rates and time depending on actual crops nutrient supply and availability.

The special normative tables are used for determination of fertilizer rates, or it is done by a professional agronomist. The requirement for plant nutrient is characterised by calculated plant nutrient removal in expected (planned) yield. Special tables are used for estimation of plant nutrient removal. In such calculations it is very important to make a real yield goal estimate, because many factors can influence it. Some of these factors that considerably affect the yield are quite difficult to forecast, e.g. weather conditions. Soil analysis and professionally made interpretations are information sources about soil's capacity to supply plants with nutrients. Plant nutrient content in organic fertilizers and its utilization coefficient characterises the importance of this source for plant nutrition. For example, utilization rate for nitrogen in slurry could be 60 % and more in the first year after application, but only 20 – 30 % from the farmyard manure rich in straw.

An orientation about the nutrient requirement of different crops (in case of medium yield level) and therefore about the necessary fertilizer rates can be obtained from plant nutrient removal data. Usually data is expressed in kg of nutrients per one ton of the main yield considering how the byproducts are managed, i.e. whether they are removed from fields as well or they are left on the fields and plowed down in soil.

Table 9. Plant nutrient removal by crops, kg/t

Data collection made by A. Vucans and I. Gerste

Crops	Byproducts removed			Byproducts plowed down		
	N	P ₂ O ₅	K ₂ O	N	P ₂ O ₅	K ₂ O
Winter rye	23,7	10,2	22,3	16,6	7,1	5,6
Winter wheat	24,8	8,5	21,1	17,4	5,9	5,3
Spring wheat	24,7	10,2	19,8	17,3	7,1	4,9
Spring barley	24,7	10,2	19,8	17,3	7,1	4,9
Oats	26,3	10,9	31,4	18,4	7,6	7,8
Peas	51,4	13,0	25,1	36,0	9,1	6,3
Lupine	77,3	19,1	38,8	54,1	13,4	9,7
Cereal – pea (vetch) mix for grain	31,3	11,3	30,1	21,9	7,9	7,5
Barley – oats mix for grain	25,5	10,6	25,6	17,8	7,4	6,4
Corn, green forage	2,6	1,0	4,4	–	–	–
Mix for green forage	4,3	1,8	5,5	–	–	–
Winter rye for green forage	5,5	2,3	5,2	–	–	–
Lupine for green forage	18,2	4,5	9,1	–	–	–
Potatoes (early varieties)	2,8	0,9	5,0	1,8	0,7	3,2
Potatoes (late varieties)	3,0	1,1	6,2	1,9	0,8	4,0
Sugar beet	5,1	1,7	7,5	1,5	0,7	1,5
Sugar beets for forage	4,3	1,6	6,8	2,1	1,0	3,4
Fodder beet	3,6	1,1	5,1	1,8	0,7	2,5
Fodder carrot	3,3	1,2	4,2	1,6	0,7	2,1
Fodder cabbage	3,9	1,6	5,3	–	–	–
Flax, culms + seeds	10,5	3,4	10,0	–	–	–
Clover > 50 % + grasses, 1 st year	21,0	5,5	22,0	–	–	–
Clover > 50 % + grasses, 2 nd year	18,0	5,0	19,0	–	–	–
Clover < 50 % + grasses, 1 st year	16,5	4,8	18,0	–	–	–
Clover < 50 % + grasses, 2 nd year	16,0	4,5	17,5	–	–	–
Clover hay, 1 st year	22,0	7,0	23,0	–	–	–

Clover hay, 2 nd year	19,0	6,0	20,0	-	-	-
Alfalfa + grasses hay, 1 st year	18,0	5,0	23,0	-	-	-
Alfalfa + grasses hay, 2 nd year	17,0	4,8	21,5	-	-	-
Alfalfa hay, 1 st year	22,0	7,0	23,0	-	-	-
Alfalfa hay, 2 nd year	19,0	6,0	20,0	-	-	-
Clover and alfalfa for green forage	8,0	2,5	7,0	-	-	-
Grass hay	16,0	4,5	18,0	-	-	-
Meadows cultivated, hay	16,0	5,0	22,0	-	-	-
Pasture grass with legumes	4,0	1,2	3,5	-	-	-
Pasture grass without legumes	3,0	1,0	2,7	-	-	-
Clover seed + culms	24,5	5,5	22,0	-	-	-
Clover seed	580,0	130,0	525,0	-	-	-
Grass seed + culms	16,0	4,5	18,0	-	-	-
Grass seed	180,0	50,0	200,0	-	-	-
Rape seed	50,0	25,0	45,0	-	-	-
Rape green forage	3,5	1,2	6,0	-	-	-

Table 10. Plant nutrient removal by vegetable crops, kg/ha

Data collection made by A. Vucans and I. Gerste

Vegetable	Yield, t/ha	N	P ₂ O ₅	K ₂ O
Cabbage, late	400 – 500	180 – 200	75 – 80	200 – 250
Cabbage, early	300 – 350	100 – 120	30 – 40	100 – 120
Cauliflower	120 – 150	80 – 100	25 – 30	100 – 120
Carrots, parsley	350 – 400	80 – 100	40 – 50	100 – 120
Celery	200 – 250	150 – 160	60 – 65	200 – 250
Red beet	400 – 450	110 – 120	35 – 40	200 – 220
Radish	180 – 200	100 – 110	35 – 40	100 – 110
Black radish	280 – 300	175 – 180	60 – 65	150 – 160
Turnips	280 – 300	100 – 120	50 – 60	130 – 140
Swede	450 – 500	160 – 170	65 – 70	130 – 140
Cucumbers (open field)	180 – 200	50 – 60	30 – 35	60 – 70
Tomatoes (open field)	~ 100	70 – 80	20 – 25	100 – 115
Lettuce, leaves	80 – 100	20 – 25	7 – 10	45 – 50
Lettuce, heads	120 – 150	45 – 50	25 – 30	75 – 80
Green peas	70 – 80	75 – 80	45 – 50	30 – 50
Horse beans	120 – 150	125 – 130	35 – 60	80 – 90
French beans	75 – 80	75 – 80	25 – 30	45 – 50
Horse radish	100 – 120	60 – 70	30 – 35	45 – 50
Rhubarbs	300 – 400	200 – 220	80 – 100	150 – 180
Onions	120 – 150	45 – 60	25 – 35	60 – 70
Average all vegetables				
• medium yield level	-	110	45	115
• high yield level	-	130	54	138
Average fruits and berries (kg/t)	-	5,0	3,0	6,0

31. Fertilizer (organic, mineral) use should facilitate the improvement of yield quality. Its application must not enforce accumulation of compounds harmful for human or animal health.

Practical guidelines

Fertilizer use is an essential factor in the formation of yield with certain quality parameters. Depending on fertilizer rate and plant nutrient ratio, accumulation of different organic compounds could be facilitated in plant products, e.g. proteins, sugar, starch, oil, etc. These compounds are important for using crop products as food, for processing, for forage and feed. Fertilizers also considerably affect the taste of products, their processing and storage properties. Excess and unbalanced fertilization can stimulate the accumulation of undesirable compounds in yield. It can lead to serious physiological imbalances for the consumers of products. For example, high potassium in forage, especially in the pasture grasses, is a result of abundant potassium fertilization. High nitrogen contents in a form of nitrates in vegetables and forage are due to high and unbalanced application of nitrogen containing fertilizer.

Do not use more nitrogen than recommended to keep the crop products healthy for the consumers.

Table 11. Maximal recommended concentrations of nitrogen in the form of nitrates in crop products

mg per kg of natural (moist) products

Crops	Allowed concentration of nitrates, mg/kg	
	grown in open field	grown in greenhouses
Potatoes, early (harvested before 01.09.)	200	–
Potatoes, late (harvested after 01.09.)	140	–
Cabbage, early	700	–
Cabbage, late	500	–
Carrots, early	300	–
Carrots, late	200	–
Tomatoes	50	100
Cucumbers	150	300
Onion leek	400	600
Lettuce	1200	2500
Dill, parleys, celeries, sorrel, spinach, beet leaves	1000	2000
Marrow, pumpkins, sweet pepper	200	400
Aubergines, cauliflower	300	–
Swede, turnips	500	–
Radish, black radish	1500	–
Red beets	1400	–
Onions	80	–
Rubarbs	800	–

32. Commercial growers (fertilizer area more than 10 ha) should provide annual calculations of plant nutrient balance for the farm.

Plant nutrient balance (N, P, K, Ca, Mg, etc.) calculation shows the efficiency of the nutrients and risk for pollution of the environment. It is a difference between their input and output expressed on a certain area (field) or on a farm, region, state. If the input is higher than output, the balance will be positive, and vice versa – negative, if the output is higher than input.

Importance of plant nutrient balance calculations

- resources planning and its rational use in agriculture;
- soil fertility management;
- prognosis of plant nutrient status in soil, their dynamics and change;
- assessment of fertilizer requirements;
- assessment of actions and measures for environment policy and protection.

Intensity of plant nutrient balance is an input/output ratio expressed as a percentage. It is used to evaluate the plant nutrient flux in a fixed time interval, e.g. one year. Usually it should be 100 – 120 % for nitrogen, or 120 – 150 % if the yield level is above 5 t/ha (in grain units). Pollution risk increases if the values exceed aforementioned. The recommended balance intensity for phosphorus could be 160 – 200 %, for potassium – 120 – 150 %, depending on PK level in soil.

Practical guidelines

Farmers should strive to reach the balance that is lower or normal for the specific farms under certain conditions.

33. Mineral fertilizers should be applied shortly before the maximum plant nutrient uptake. Application is not allowed if essential nutrient losses are feasible due to emission, surface run-off or leaching. It is prohibited to use the nitrogen containing fertilizers in the fall for crops planted or seeded only in the next spring.

Practical guidelines

It is necessary to limit the time interval between the application of easily soluble mineral fertilizers and period when plants are able to uptake the nutrients most intensively. Spring application of mineral fertilizers is strongly recommended for annual crops instead of their use in fall of previous year. The aim is to reduce the risk of plant nutrient leaching or its transformation in less available form. It is prohibited to apply the fertilizers in the following circumstances

- on frozen or snow covered soil;
- if flooding risk of fertilized field exists;
- if soil is water saturated in such extent that infiltration can happen.

The split application should be performed for crops requiring high fertilizer amounts.

34. Special precaution should be followed in fertilizer use in vulnerable and high-risk areas or conditions to prevent migration of nutrients into waters and water intakes.

Practical guidelines

The following vulnerable and high-risk areas or conditions could be pointed out that require special precautions in fertilizer use:

- **rolling topography.** Fertilizers should be incorporated in soil just after application. No incorporation is only allowed if plant cover is well developed;
- **areas that could be flooded in the certain period of a year.** Fertilizers should be used only as the period of possible flooding is over;
- **areas where groundwater level reaches soil surface.** Fertilizers could be used only when groundwater level goes down and field are dried;
- **areas that border with waters.** It is not allowed to use the fertilizers close to the coastline of rivers, channels, lakes, ponds, and water intake places. The cleaning of fertilizer application equipment and other machinery is prohibited in this zone. Surface waters and their inhabitants are very sensitive to the presence even if small amounts of fertilizers. Fertilizer use is prohibited within the 10-meter zone of coastline⁵;
- **sandy soils with** low organic matter content and acid. Lower rates of fertilizers should be used and split application is recommended.

35. If plant protection compounds (pesticides) are included in fertilizers all regulations concerning pesticide use must be followed.

Some fertilizers, particularly liquid ones, can be used in the mixture with plant protection agents – herbicides or fungicides. In this case all regulations mandatory to the pesticide use should be followed.

36. The best available technology should be used for fertilizer handling and used in a way to provide the maximum effectiveness with the minimal negative side effect on crops and environment.

Practical guidelines

Technology of fertilizer use includes several important steps: organisation, selection of machinery, its adjustment, and quality control. In order to obtain the best possible performance, the main aspects to consider are as follows:

- the selection of fertilizer application method that should meet the agronomic, economic and ecological requirements. Priority should be given to the methods that provide incorporation of the fertilizers directly into soil or the plant root zone;
- the best possible pattern should be followed to obtain an even application. If the incorporation in

⁵ Law of Protection Belts

⁶ Law of Plant Protection

soil is performed, fertilizers should be placed so that plant roots can easily reach them. For example, undesirable results like heterogeneous harvest ripening, crop lodging, etc. are due to the unevenness of fertilizer application, especially nitrogen. The amount of fertilizers applied must not differ more than $\pm 10\%$ from the calculated (recommended) quantity;

- application pattern of fertilizers depends on many factors: type of applicator (spreading equipment), its adjustment, quality of fertilizers (physical properties), field conditions, methods of application, qualifications of operator, etc. All these factors should be known and considered to obtain good fertilizer application quality;
- Fertilizer application quality should be checked periodically, and necessary adjustments should be performed.

37. Commercial growers (fertilizer area more than 10 ha) should compile a crop fertilizer plan and field history annually.

Practical guidelines

Fertilizer plan – professionally made document of recommended actions and measurements for fertilizer use, that is based on assessment of relevant farm conditions. It includes fertilizer recommendations as well as managerial and technical guidelines that are based on resources available in the farm. The main factors that should be considered in composition of a fertilizer plan are following:

- kinds of crops cultivated and estimated yield goal;
- soil conditions (topography, type, texture, plant nutrient status, and water conditions);
- climatic conditions;
- land uses type, agrotechnics used, farming intensity, crop rotations;
- other sources of plant nutrient, their contribution (manure, green manure, straw, leguminous plants);
- fertilizers that are more suitable for the specific situation, their price;
- equipment, machinery available on farm.

It is strongly advisable that fertilizer plan is worked out by an experienced professional, i.e. agronomist. It is an important document from agronomic, economic and ecological aspects. The final result to a large extent depends on the plan's logistics, quality and realisation sequence.

Field history – document that contains regular records about soil improvements, agrotechnics used, the use of fertilizers, pesticides, obtained yield, different observations, etc. The field history records show specifics of crop growth conditions for every single field in the farm and accumulate experience for possible future use to avoid repeating mistakes. It is useful for experience and knowledge transmission to the next generations. It gives information that is essential for preparation of recommendations. Therefore, close relationship exists between good field history documentation and well-prepared fertilizer recommendations.

Fertilizer planning should be based on the newest available soil fertility data. Therefore, soil fertility survey should be done periodically (at least once per 5 years). Especially, mineral nitrogen content in soil should be tested before the nitrogen fertilizer use in farms with very intensive crop production and fertilizer use. The plant nutrient balance should be also calculated annually.

The principles in fertilizer planning suggest that firstly the required amount of applied plant nutrients should be determined according to the needs. Next, it should be decided what share of the norm can be covered by animal manure of a certain type. Finally, types and amounts of mineral fertilizer to cover the remaining needs should be determined. See an example in the Table 12. An empty form for use your use in preparation of a fertilizer plan for a field is provided in Appendix 1.

Table 12. Example of a fertilizer plan for a 4,5 ha field with winter wheat with an expected yield of 6,5 ton per ha

The need is roughly assessed according to Table 9. The amount of manure and plant nutrients in it is assessed according to Table 8.

Calculation	Amount	Plant nutrients, kg		
		N	P ₂ O ₅	K ₂ O
1 Norm* (need) per ha (Table 9.)		161	55	137
2 Norm (need) per 4,5 ha (Line 1 x 4,5)		725	248	617
3 Manure from 12 dairy cows, tons (Table 8.)	112	605	246	470
4 Effective fertilizing value of the manure, % (estimate dependent on application time and technique, etc.)		35	40	40
5 Effective fertilizing value of the manure, kg (Line 3 x line 4 / 100)		212	98	188
6 Difference to be applied as mineral fertilizer (line 2 - line 5)		513	150	429
7 Plant nutrient content in used fertilisers (ammonia nitrate, superphosphate and potassium chloride)		34	20	60
8 Ammonia nitrate to comply with the rest of need (line 6 / line 7 x 100), kg	1509	513		
9 Superphosphate to comply with the rest of need (line 6 / line 7 x 100), kg	750		150	
10 Potassium chloride to comply with the rest of need (line 6 / line 7 x 100), kg	715			429

*The norm is determined from the standard normative (Table 9.), adjusted for the field's history (under the fertilizing effect of the previous crop), pH of the soil, soil type, soil analyses (under N_{min} analyses), and for the climate in the region.

38. Special regulations must be followed if sewage sludge is used for soil improvement or fertilization. Harmful compounds (mainly heavy metals) may be present in sludge and, therefore potential risk for human health and environment exists⁷.

⁷ Regulations of Council of Ministers of Latvia "Use of sewage sludge for soil improvement".

The following rules should be considered in use of sewage sludge for soil improvement:

□ the maximum allowed concentrations of heavy metals and PCBs must be considered;

□ soil reaction must be higher than $\text{pH}_{\text{KCl}} 5,0$ and heavy metal content in soil must not exceed the limits set up for every soil textural group;

□ the limits for sewage sludge application that are set up based on nitrogen and phosphorus content must not be exceeded. Attention should be paid to decide the crops to be grown, their rotation, and other agrotechnical characteristics.

2. ANIMAL HUSBANDRY



2.1. INTRODUCTION

Animal Husbandry is a branch of agricultural production dealing with animal produce output and satisfaction of people hobbies or other special interests. It is also the science of animals, their feeding and nutrition, breeding, management.

Specialisation of Animal Husbandry depends on food industry requirements for specific raw materials, on natural circumstances and on market demands. Two different methods, extensive and intensive, are characteristic in Animal Husbandry.

The extensive animal keeping method rather is a historical category. However, given the concern with animal welfare, biological agriculture, and unpolluted produce output this method is being used to a certain extent.

Intensive Animal Husbandry is based on well - developed cultivation of plants. It is characterised by a rapid increase of animal productivity and of the number of animals in a fixed territory.

We have to be conscious of the harmful and even hostile influence of the intensive animal husbandry on the environment. It pertains to low utilization of ingested feed nitrogen compounds for animal protein as well as low utilization of phosphorus. Usually, faeces and urine excrete more than 60% of feed nitrogen. The amount of excreted nitrogen in some places is so large that the natural nitrogen cycling processes is no longer possible.

In conformity with Latvia's legislation, EU Directives and HELCOM references the issues of great importance on the state level and for every farm are following: **density of livestock, control of the microclimate of livestock buildings, decrease of ammonia emission from manure by the improvement of nutrition, storage of forage, disposal of animal carcasses, animal welfare and health status as the base of qualitative manufacturing of animal produce.**

The majority of issues in Animal Husbandry chapters of the Good Agricultural Practice have a status of recommendations. However, in the nearest future they should be prescribed by law.

2.2. DENSITY OF LIVESTOCK

39. In livestock buildings conditions for keeping animals have to be secure and corresponding to zoo-hygienic requirements. The livestock recording has to be carried out according to the legislation of the Republic of Latvia.¹

40. The number of animals and the agricultural land area used for manure application should be kept in balance. Livestock unit is used as an index to describe the number of animals per area.

¹ Pedigree record normative documents. 1.volume. Ministry of Agriculture of Latvia Republic, Riga, 1998

Practical guidelines

Livestock Units (IU) is determined as the number of animals that produce an amount of manure equivalent to 100 kilo Nex storage. The amount of manure produced by different animals in different housing systems, bedding types and productivity level is shown in Table 8 of Chapter 1. Table 13 shows the number of Livestock Units per animal and the number of animal per one IU, and is calculated from Table 8.

An empty form for calculation of Livestock Units and livestock density in your own farm is provided in Appendix 2.

Table 13. Livestock Units (IU)

Housing system	Manure type	IU per animal	Animal per IU
Sow with 18 piglets to 20 kg weight			
Solid floor	Solid manure	0,21	5,0
Slaughter pig, 20 – 100 kg live weight			
Slotted floor	Slurry washing	0,10	10,0
	Periodical flush	0,09	11,0
Solid floor	Slurry	0,12	8,0
	Solid manure	0,15	7,0
Dairy cow, milk yield 3500 – 5000 kg per year			
Tie up, solid floor	Solid manure	0,6	1,6
	Slurry		0,5 2,0
Dairy cow, milk yield 5000 – 7000 kg per year			
Tie up, solid floor	Solid manure	0,8	1,2
	Slurry		0,6 1,5
Dairy cow, milk yield above 7000 kg per year			
Tie up, solid floor	Solid manure	1,0	1,0
	Slurry	0,8	1,3
Young stock (cattle), up to 6 month old			
Tie up, solid floor	Solid manure	0,14	7,0
	Slurry	0,11	9,0
Tie up, deep litter	Solid manure	0,18	6,0
Heifer, 6 to 24 month			
Tie up, solid floor	Solid manure	0,37	3,0
	Slurry	0,33	3,0
Tie up, deep litter	Solid manure	0,41	2,0
Bull, from 6 months up to 450 kg live weight (26 months)			
Tie up, solid floor	Solid manure	0,52	2,0
	Slurry	0,45	2,0
Slotted floor	Slurry	0,45	2,0
Free, deep litter	Solid manure	0,63	2,0
Horse			
Tie up, solid floor	Solid manure	0,4	2,4

continue in page 44 □

Table 13 Continuing

Housing system	Manure type	IU per animal	Animal per IU
Sheep			
Deep litter	Solid manure	0,07	14,0
Hens			
Deep litter	Solid manure	0,01	100
Battery	Slurry	0,01	100

41. The regulations of intensive animal breeding have to be followed to prevent or decrease the adverse influence of livestock density on the environment. The construction and reconstruction of complexes of intensive animal breeding require an assessment of the impact on the environment.⁹

The law prescribes that the assessment of the influence on the environment is necessary also for other facilities as required by the regional departments of the environmental protection. The most of farm manure and slurry storage facilities do not correspond to the demands of environmental protection in Latvia. Thus, in the farms exceeding 10 Livestock Units it will be necessary either to construct new or reconstruct the old manure and slurry storage facilities and perform an assessment of their influence on the environment⁹.

Today the law determines that impact assessment on the environment is required for the building and reconstruction of pig and poultry intensive breeding complexes containing more than:

- 85 000 broilers;
- 60 000 laying hens;
- 3 000 pigs with live weight more than 30 kg;
- 900 sows⁹.

2.3. MAINTAINING OF MICROCLIMATE IN LIVESTOCK BUILDINGS

42. Slurry and manure should be frequently removed from the stables.

Livestock production is the major source of the emission of different odours and gases in the atmosphere usually arising from livestock buildings, manure and slurry storage facilities and from the

⁹Law on The Assessment of Influence on the Environment

application of manure and slurry on the farmland. Frequent removal of slurry and manure will help to control the emission of smells and gases from livestock buildings.

Practical guidelines

- In livestock buildings manure and slurry has to be collected and transferred to a suitable storage every day.
- Farm vicinity and manure storage facilities should be kept clean.
- Slurry leakage from manure storage should be prevented.
- Use enough bedding where appropriate to keep animals clean.

Table 14. Indispensable mass of bedding per one animal

Group of animals	Form of bedding	Daily normative, kg	
		Collecting slurry separately	Collecting slurry with bedding
Dairy cows	straw	2,5–3,0	6,0–7,0
	peat	2,0–2,5	7,0–8,0
Sows	straw	3,0	5,0–6,0
	peat	3,0	5,0–6,0
Fatteners	straw	1,5	2,5–4,0
	peat	1,2	1,5–3,0
Sheep	straw	–	0,5–1,0
Horse	straw	2,0–2,5	4,0–5,0
	peat	1,5–2,0	5,0–6,0
Hens	peat	–	0,015–0,030

The indispensable amount of beddings is calculated assuming that the moisture of chopped straw is 20%, and of peat – 40%. If peat moisture reaches 50%, the amount of the used bedding has to be increased 1,25 times. If 60%, it should be increased respectively 1,5 times. The bedding has to be stored in dry places to avoid the formation of mould and dust that diminishes the moisture absorption capacity of the bedding.

Manage drinking systems to avoid overflow and spillage.

If livestock is kept in groups, thoroughly clean and disinfect buildings after each batch or stock is removed:

- dust should be removed accurately from all inner surfaces of farms, particularly, from different wrinkles, ventilation shafts, engine bonnets;
- keeping animal pens clean can diminish odour emission.

Uncleanliness and anti-hygienic conditions are the result of different reasons, including unskilled management and farm construction. Increase of animal density, bad ventilation, discrepant construction of animal pens, poor floor surface, bad functioning of feeding and drinking equipment create untidiness in animal pens.

If livestock is kept individually, clean and disinfect individual pens thoroughly when they are empty:

- the pen must have suitable dimensions to keep clean a dairy cow tied to an individual pen. The bedding has to be always clean and unspoiled. It has to be added every day;
- Passages between individual pens have to be cleaned very carefully and daily.

Dairy and parlour buildings need to be washed and cleaned frequently. If disinfectants are used, make sure you have the correct type and quantity of disinfectant and the right volume of washing water. If high-pressure hoses are used, take care to avoid splashing of manure on walls, ceilings, and milking equipment.

Clean out grit and sediment from slurry channels, collection systems and stores. Thick sediments encourage microorganisms to grow and produce bad odorous.

Areas of concrete used by livestock should be cleaned after animals are removed.

Poor ventilation can result in humid conditions that stimulates unpleasant odorous, high levels of ammonia, and poor animal health. Ventilation fans should be maintained, and the farmer has to check whether they function with the correct airflow corresponding to the numbers and weight of animals.

2.4. DECREASE OF AMMONIA EMISSION FROM ANIMALS BY THE ENHANCEMENT OF NUTRITION

43. Animals should be fed according to balanced feed rations in order to minimise emission of ammonia from the animal organism.

Practical guidelines

Cattle use productively about 24% of the ingested feed nitrogen protein, pigs – up to 40%. Faeces and urine excrete the remainder.

To improve the productive use of nitrogen:

- protein rationing has to be used for dairy cows and ruminants in nuren degradable and nuren not degradable fractions;
- the corresponding ideal protein model has to be achieved for pigs of each productivity group by use of synthetic amino acids. The total amino acid requirement has to be stabilized, thus reducing the total nitrogen intake and excretion in faeces and urine;
- the farmer has to consult on these issues with the Latvian Agricultural Advisory experts in Ozolnieki, Jelgava, or with advisors from local district offices or experts of Latvia University of Agriculture. Every farm has to perform chemical analyses of the produced forages.

2.5. STORAGE OF FORAGE

43. A correct storage and utilization of forage should ensure proper animal sanitary conditions in animal buildings and in the production of qualitative and unpolluted animal produce.

Practical guidelines

Finely ground feed and feed remains (in bins and on floors) increase the amount of dust. Odours can be absorbed by dust particles and thus diffused in the air.

To improve the situation:

- try to use new mechanisms for preparation of concentrated feed – grain flaking, high-moisture grain preservation, for pigs – pelleted mixed feed feeding with moisture technology;
- it is preferable to use the mixed concentrated feed in a pelleted form.

Keep food such as milk by-products (whey, skimmed milk), yeast, and molasses, that can produce strong odours in properly constructed covered tanks or silos. Feed animals very carefully.

Odours from silage clamps sometimes create problems in dairy production. Well-made silage causes less odours than the silage that is not produced qualitatively.

Balled silage has the advantage as it is enclosed until you use it, thus only a small quantity of this product is exposed at any time. Careful use of this technique can help to limit the amount of odours released.

2.6. DISPOSAL OF ANIMAL CARCASSES

45. Animals carcasses should be disposed of at a rendering plant¹⁰.

Disposal methods on the farm such as burial or burning in the open may cause water or air pollution.

Practical guidelines

Never dispose of carcasses in or near watercourses. Apart from causing water pollution it involves a serious risk of spreading diseases to animals of neighbouring farms.

You should report any suspicion of a disease that has caused ill health or death of animals to Veterinary Offices at the local Animal Health Agency. Carcasses should be made available for post-mortem examination in such cases.

If no disease is suspected, and no other means for the disposal of carcasses are practical, the carcasses can be buried on the farm as long as the following rules are met:

- the burial site must be at least 250 metres away from any well or spring that supplies water for human consumption or for the use in farm;

¹⁰ Law on Veterinary

- the burial site must be at least 30 metres away from any other spring or watercourse and at least 10 metres away from any field drain;
- the bottom of the buried pit should have at least one metre of subsoil above it, so that the carcass is covered by at least one metre of soil below the topsoil;
- the bottom of the burial pit must be free from standing water.

2.7. ANIMAL WELFARE AND HEALTH STATUS AS THE BASE OF A QUALITATIVE MANUFACTURING OF ANIMAL PRODUCES

43. Manufacturing of animal produces should be done with consideration of animal welfare and health conditions.

Practical guidelines

Animal health conditions and, consequently, consumer health depend on the following factors:

- use of growth promoters and antibiotics;
- unfavourable conditions for animal welfare and threats to animal health;
- use of genetically modified organisms in agriculture.

An intensive use of growth promoters and antibiotics causes serious problems for human and animal health. Moreover, many bacteria develop immunity against antibiotics, and thus undermine prospective efforts in their extermination.

A raise in the intensity of breeding and pedigree record and the improvement of feed quality and keeping conditions as appropriate for each animal species will diminish the necessity for antibiotics.

It is not permitted to use growth stimulators including hormone preparations, because it is not possible to predict their concentration in animal produce.

In order to improve animal health and welfare it is necessary

- to use well balanced feeding rations;
- to avoid long transportation of animals;
- to provide a suitable extra space for exercises.

The quality of animal produce is important for the consumer as well as the producer

- consumer should be able to choose high quality and healthy products;
- information about the production conditions should be available for consumers;
- the quality offers the producer an advantage in the advertisement of his goods.

The use of genetically modified organisms in agriculture increases every year. In animal husbandry it is an ethical problem, and it has to be evaluated as a very risky undertaking.

3. COLLECTION AND STORAGE OF ORGANIC MANURE



3.1. INTRODUCTION

Livestock farms, manure storages and silos are critical sources of dangerous pollutants due to a high concentration of chemical elements (especially nitrogen, phosphorus) and high content of organic matter in the manure and in the run-off. Nitrogen evaporates mainly in the form of ammonia from these buildings to atmosphere. Soil accumulates different chemical compounds and organic matter. However, if such substances are disposed of continuously, possibilities of their leaching from soil will increase. Phosphorus, ammonium nitrogen, and organic matter are usually bound in the topsoil and can reach watercourses in the surface run-off with out-washed soil particles. The nitrate nitrogen is mobile in soil, and its transmigration with run-off stream can pollute the groundwater.

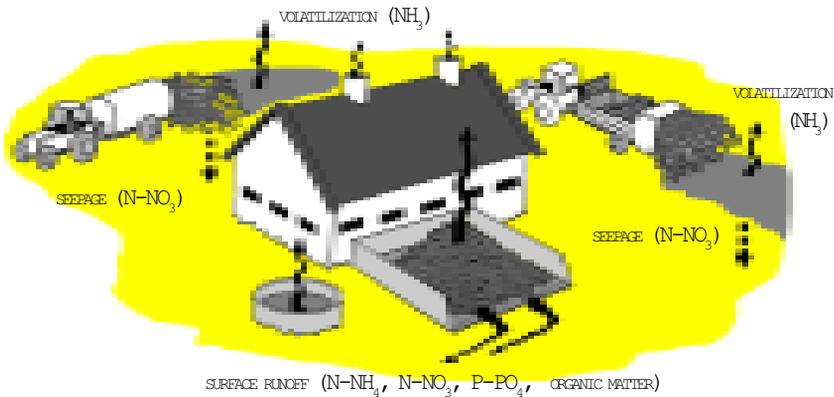


Figure 1. The influence of organic fertilizers on the environment

A rational utilization of plant nutrients and protection of the environment are mutually interconnected processes. Carefully managed and utilized plant nutrients have less pollution impact on the environment and at the same time increase the yield.

3.2. THE LOCATION OF FARMS, MANURE STORAGES AND SILOS

- 47 • Livestock buildings, manure and silos storages should be located in a way to minimise their harmful influence on the environment.

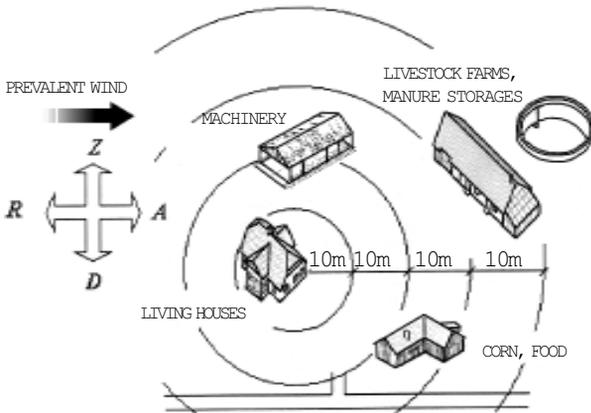


Figure 2. An advisable location of buildings in a territory of a farm

Practical guidelines

The construction of new livestock buildings should take place in an appropriate location against the living houses taking into consideration the prevalent wind direction.

The stable should be located along the north – south direction to improve the lighting and ventilation of the stable. It is useful to locate the manure storage in the eastern side of the barn to limit the diffusion of odours in the rest of the farm's area.

Collection and draining of precipitation from roofs should be implemented to improve the farmyard conditions after rainfalls and to restrict the dissipation of pollution to the environment.

48. It shall be ascertained that there are no restrictions applying in the territory of the construction of livestock barns, manure storages or silos. The minimum distances to the objects of high hazard must be observed.^{5; 11; 12}

Additional information

The existing legislation prohibits building of new farms, storages for fertilizers, silos, and enlargement of the existing farms in the following areas:

- shelter belts of the dunes of the Baltic Sea and the Riga Gulf;
- shelter belts of rivers and other watercourses;
- nature reserve areas of strong regime;
- restricted areas of national parks;
- restricted areas of biosphere reserves;
- nature conservancy areas;
- nature parks;
- periodically flooded areas;
- greenbelts in cities.

Following minimum distances to specific objects should be considered in the location of new

⁵ Law on shelter belts

¹¹ Rules for protection and recreation on territories of special preservation

¹² Method on designation of shelter belts around the water-supply sources

farms, manure storages, and silos:

- 50 m to watercourses and water streams (including collecting ditches of melioration systems), but not less than the prescribed width of shelter belts (Chapter 5);

- 500 m to water basins used for centralised water-supply systems;

- 1000 m to health resorts, if not stated otherwise;

- 500 m to memorials, if not stated otherwise;

- 200 m to hydro meteorological monitoring stations and stationary monitoring posts of state significance.

Following distances to other objects are recommended to prevent deterioration of the environmental situation:

- 20 m to other ditches of melioration systems (interruption and drainage channels), underground water collection places;

- 30 – 50 m to wells, depending on local conditions;

- no less than 15 m to living houses in farms;

- 200 m to public buildings (living houses, schools etc.);

- 500 m to populated areas, cottage areas, areas of gardeners' associations,

- 20 m to the borders with other land properties;

- 200 m to locations of protected plants, and rare biotas.

An increase of the production is not allowed in the farms located within the aforementioned distances. Their further operation is allowed only after measures to improve the environmental situation are implemented. Manure storages shall be reconstructed if needed to ensure prevention of any seepage, decrease of ammonia evaporation by covering manure storages (especially, nearby populated areas), and prevention of any surface run-off from manure storages.

3.3. NECESSARY MANURE STORING PERIOD AND VOLUME OF STORAGES

49. The volume of storage facilities should be large enough to storage manure during the period when spreading is not allowed. Litter manure storages should provide accumulation of the volume produced during at least 6 months, but slurry tanks – for 8 months period.

Practical guidelines

The typical climate conditions promote the plant nutrient leaching during the whole year in Latvia. However, its quantity depends on the season and local conditions. It is important that the largest amount of leaching occurs in periods with less plant vegetation – in spring, autumn and in winter. The losses of leached plant nutrients can be very considerable during the aforementioned periods due to the high

water level in ditches, and intensive operation of drainage systems and rivers.

The spreading of manure before or after vegetation periods significantly increases the losses of plant nutrients. The relative shortage of plants and the elution regime of water seepage promote the leaching of plant nutrients under climatic conditions of Latvia. Therefore, the spreading of fertilizers is not advisable in winter, in late autumn when the rainfall season has started, and in very early spring when drainage systems operate intensively.

The length of manure accumulation and storage period should be considered in calculations of the volume of manure storages. In Latvia the manure spreading period continues from middle April to middle October, therefore the volume of farmyard manure (FYM) storages should be envisaged for at least a 6 months storage period. The volume of storages should be increased considering 8 months of accumulation, if water is used for manure collection and transportation. It is recommended to collect urine into separate reservoirs intended for 8 months storage period.

An empty form for calculation of the required manure storage capacity of your farm is available in Appendix 3. In principle, the capacity of each type of manure storage should be calculated respectively, i.e. separate calculation for storage of solid manure and for slurry. It is assumed that a ton of manure equals to a volume of 1 m³. It is approximately correct for most manure types. If manure is mixed with large amounts of bedding material (straw, wood chips or peat), the density is smaller, and it should be considered when converting tonnes to m³. See Table 15 for converting from tonnes to m³.

3.4. MANURE ACCUMULATION AND STORAGE

50. Farmyard manure should be accumulated and stored in a way to minimise the losses of plant nutrients, and to avoid the influx of precipitation into storages. The construction of storages should provide for reliable and convenient operation.

Practical guidelines

In order to prevent the urine and manure leaching in groundwater, the floors, manure channels and reservoirs should be impermeable and of a proper mechanical and chemical resistance. The inspection of impermeability and reparation of defects should be performed periodically.

To minimise the volume of precipitation influx in storages:

- areas of access roads and manure storages should be planned as small as possible;
- litter manure should be stacked in heightened piles (2 – 4 m) to facilitate self-compaction of manure.

Table 15. The amount of manure (FYM) depending on the height of heaps on 1 m² storage area

Height of heap m	Amount of manure on 1m ² t/m ²	Density t/m ³
1,0	0,85	0,85
1,5	1,32	0,88
2,0	1,80	0,90
2,5	2,30	0,92

Considering the gradual filling of storages and eventual changes in herd size, it is recommended to section the storage area to provide for convenient collection of manure effluent and rainfall water from the storage's area used for manure unloading.

Walls increase the capacity and facilitate convenient emptying of the storage if erected in 1,0-1,5 m height and in width of at least 0,2 m.

If manure is unloaded near the barn, an empty zone in width of 1,5 – 2,0 m should separate manure and the barn.

The surfaces covered with manure should have a slope of 1-3 % towards the reservoirs to ensure the collection of leached liquids.

Roofs should be provided with waterspouts to carry water outside the storage's area in order to avoid precipitation influx in storages.

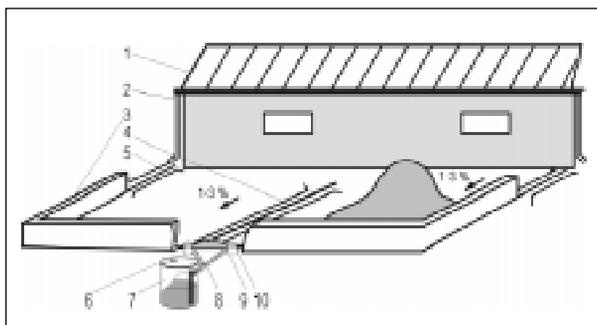


Figure 3. Scheme for the storage of litter manure: 1- stable, 2 - water-spouts, 3 - wall, 4 - elevated storage floor, 5 - elevated edging, 6 - tank, 7 - lid, 8 - pipe, 9 - grid, 10 - pit for sediments.

Stalk materials in the thickness of 0,3-0,5 m should be used for the underlay of manure piles to absorb the manure effluent and accumulate the rainfall. Heaps should be covered by a layer of peat or chopped straw to minimise the losses of ammonium nitrogen. Piles covered by layers of air insulation (i.e. plastic sheets, rubber, etc.) decrease the composting processes and reduce the losses of plant nutrients.

The amount of manure per area unit of storage can be increased if litter manure is heaped in high piles. Trailers should be placed on solid and impenetrable ground that would drain off leached liquids into the reservoirs.

Storage of manure is not acceptable on the field. Nevertheless, as an exception, field manure storage might be situated in plain and dry sites with little penetrable soil. A layer of peat, straw or other absorptive material of at least 0,5 m should be placed under manure heaps. The compacted manure should be covered with a 0,2 – 0,4 m deep layer of peat or chopped straw. Field manure storages should not be located in the same places as in previous years.

Slurry storage reservoirs may be of different constructions, however few basic principles should be considered in their construction. A slurry inlet should be provided below the level of liquid in tanks, i.e. via water seal, to avoid the inflow of poisonous gases in the barn. The volume of preparation tanks should ensure accumulation of slurry produced in a period of at least two days. However, for a convenient use of a tractor drive pump for transportation of slurry to the main storage, the preparation tank should provide an accumulation of slurry for 7 – 30 days. The mechanic and chemical characteristics of slurry reservoirs and manure storages should guarantee operation for a period of at least 20 years.

The inlet of slurry should be placed close to the bottom of the storage to minimise the nitrogen losses in the form of ammonia. The losses of nitrogen can be further reduced by covering the slurry surface with a layer limiting the access of air (plastic sheets, seed oils, stable materials) or by an installation of roof over the storage. The slurry should be mixed only before emptying the storage. Equipment of respective power should be used for this purpose (for example, tractor drive mixer).

For safety of humans and animals the uncovered storages must be surrounded with a fence in the height of at least 1,5 m. Warning signs should be placed nearby the slurry tanks.

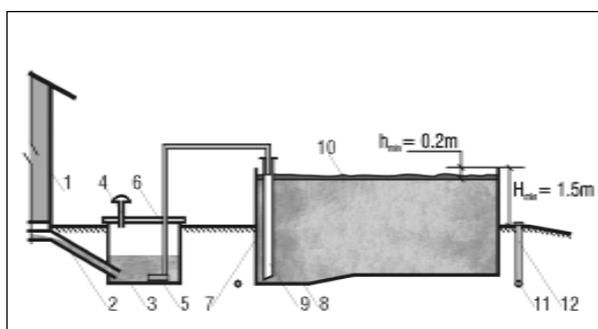


Figure 4. Scheme on slurry collection: 1- stable, 2 - input tray, 3 - preparation tank, input pipe in store, 4 - ventiduct, 5 - pump, 6 - lid for tank, 7 - slurry storage, 8 - socket for emptying, 9 - pipe, 10 - layer for air insulation, 11 - drains, 12 - well for control of water.

Covered storages should be constructed for accumulation and storage of poultry manure, unless special manure processing or composting technology is used. It is impossible to keep fresh poultry manure in large heaps due to their high water content, and substantial plant nutrient losses occur if manure is stored in small heaps.

51. Manure storages or special constructions should be used for manure composting.

Practical guidelines

The constructions of composting places should have floors of impenetrable materials. Leached liquids should be collected and stored. Plain and never flooded sites have to be chosen in case the composting is done on the field. At least 0,5 m deep layer of peat, straw or other absorptive materials should be placed under heaps.

3.5. CONSTRUCTION OF STORAGES AND MATERIALS

52. According to law storages shall be built from qualitative materials and technologies to ensure their safety^{13, 14}.

Practical guidelines

The building of storages shall be performed according to the existing building normative and regulations.

The floors of manure storages should be at least 150 mm thick (concrete class B25). The walls of slurry pits and manure stores should be planned at least 150 mm thick, but the supporting walls for manure storages should be constructed 200 – 250 mm thick (depending on their height).

The bed for the floor of storages should be a 150 mm deep layer of sand and gravel. The concrete used in constructions must be of high quality (class B25). The floor should be divided (with wood lathes, iron profiles etc.) in areas up to 35 m² in order to prevent the emergence of fissures.

The recommended size of armature net for floors is 150x150x8 mm. The joints of armature are spliced in 300 mm. Special measures to increase impermeability of concrete are not necessary given the physical characteristics of manure.

3.6. MANURE SPREADING

53. The manure spreading should be done qualitatively with special attention to the machinery used.

Practical guidelines

Soil compaction should be avoided during the manure spreading. Soil containing excess moisture is especially sensitive to compaction. Soil compaction is reduced if wide tires of low pressure are used. Spreading of manure should be performed in a way to reduce unnecessary driving on fields. Manure should be spread as evenly as possible. For example, it is advisable to provide the spreading equipment with trailing hoses for slurry spreading. Thus, no slurry reaches leaves of plants, and the losses of nitrogen are minimized.

¹³ Construction law

¹⁴ Common normatives for construction

3.7. SILAGE EFFLUENT COLLECTION

54. Silage effluent that is produced during the silage preparation and storing should be collected. The leaching of silage effluent to the environment must be prevented.

Practical guidelines

The amount of silage effluent makes about 5 – 10% of the volume of herbage dried previously or 20% of the volume of green herbage. A proper use of technology and preservative substances can reduce the excretion of silage effluent. The leakage of silage effluent in watercourses, even in small amounts, can cause death of fish and other water creatures.

Silage effluent can be collected in slurry tanks or in special underground reservoirs. It can be collected and stored in slurry pits if silage effluent is mixed with slurry not to exceed 5% of the total volume.

In order to provide a proper maintenance of constructions, it has to be considered that silage effluent promotes the corrosion of different materials, including steel and concrete.

Silage effluent can be utilized for fertilization in a rate of up to 50 m³/ha.

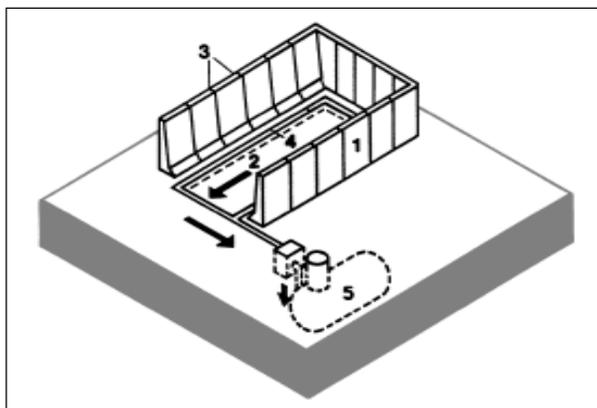
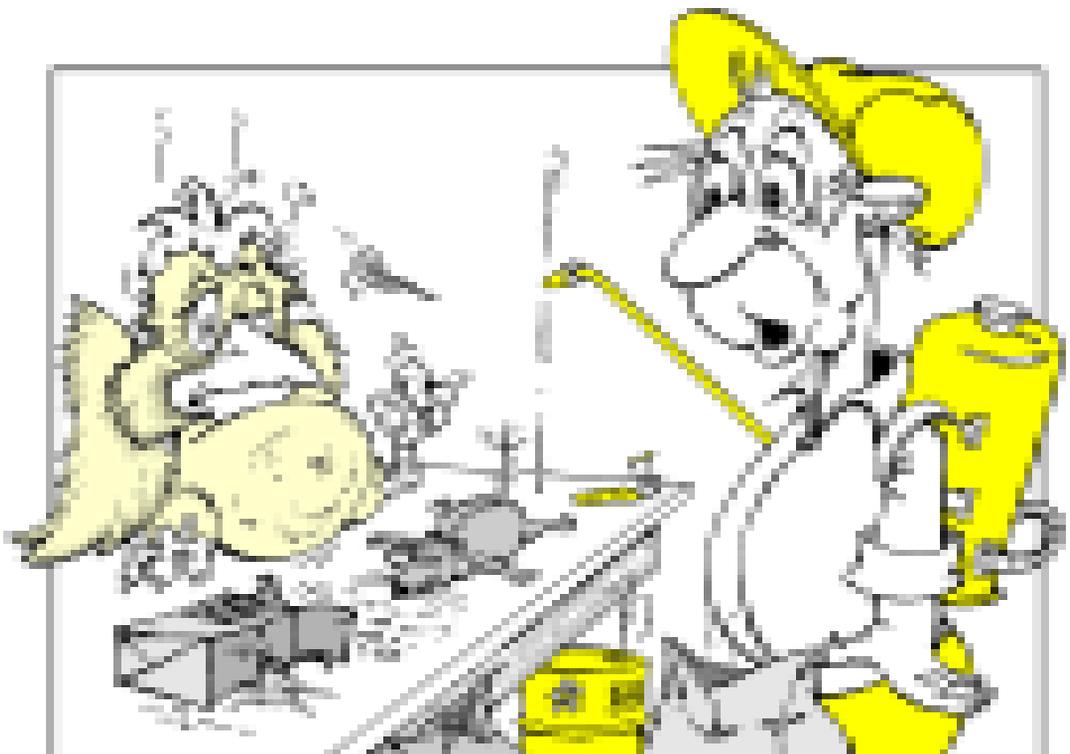


Figure 5. Scheme of the collection of leakage from silo: 1 - silo for ensilage, 2 - concrete, 3 - seals packed with pitch or mastic floor (concrete or bituminous), 4 - tray for the collection of silage effluent, 5 - tank for the storing of the leached silage effluent.

55. The aforementioned manure regulations are recommended for all farms, and should be strictly observed by farmers that possess more than 5 livestock units.

4. PLANT PROTECTION



4.1. INTRODUCTION

Plant protection is a branch of crop production that studies biology and ecology of harmful organisms of agricultural crops, and develops methods to control and to prevent the damage to crops and losses of yield.

Different methods – biological, agrotechnical, chemical, mechanical, integrated – are used for the control of pests and diseases of agricultural crops.

Biological methods – use of biological plant protection products (PPP) in order to control and prevent damage of crops by harmful organisms, to improve conditions for natural enemies of pests, and use of biologically active compounds to attract and control pest insects, use of the biological active compounds with antagonistic properties against plant pathogens in agroecosis. However, any possible indirect adverse impact on the environment should be taken into account in use of biologically active compounds.

Agrotechnical methods – use of resistant varieties against pests and diseases. Implementation of a proper crop rotation system, of appropriate soil tillage technologies to prevent reservation of pests and diseases in plant residues and weeds. Management of crop growing conditions – optimal fertilisation, optimal sowing time, and harvesting – improves the competitiveness of crops against pests, diseases, and weeds.

Mechanical method – mechanical collection and elimination of pests and diseased plants, mechanical weeding and other kinds of mechanical control of harmful organisms.

Chemical method – use of synthetic chemical PPP in order to control harmful organisms for agricultural crops. In most cases the synthetic chemical compounds are not environmentally friendly. Thus, it is necessary to consider the risk of environment pollution caused by PPP, that directly or indirectly endangers human health, flora and fauna.

Integrated plant protection includes all mentioned specific crop protection methods. It is based on a sound knowledge about biology of pests, diseases, weeds, and management of growth conditions to improve the competitiveness of crops against pests, diseases, and weeds.

Integrated pest management including agro-technical, mechanical and biological methods uses *chemical PPP* as little as possible as compared to the chemical method. It involves a chemical control if it is not possible to prevent yield losses and the decrease in yield quality. Applying PPP the most selective products should be carefully chosen. The decision to use PPP must be based on forecasting and warnings of the development of pests and diseases and their critical economical thresholds to decrease the negative impact on the flora and fauna as much as possible.

Control measures planned for each field separately can significantly reduce the necessity of treatments with pesticides. Unclear questions should be discussed with plant protection specialists and advisors.

Information provided by forecasting and diagnostic services and weather information should be used regularly to reduce unnecessary treatments of fields with PPP.

First of all the following issues should be analysed and solved both on the State level and on level of individual farms to ensure compliance with Latvian legislation, EU Directives, and HELCOM Recommendations: **Registration of PPP, application and storage of PPP, quality of spraying equipment, alternative plant protection methods in order both to decrease the use of PPP for the protection of agricultural crops and to reduce the amount of PPP residues in agricultural production.**

4.2. REGISTRATION AND TRADING OF PLANT PROTECTION PRODUCTS

56. It is allowed to use only registered PPP that are included in the list of permitted plant protection products.¹⁵

New registered products are included in the list of permitted PPP once a year.

57. All users of plant protection products shall be familiar with Plant Protection Law⁶ and with Rules of Application and Trading of Plant Protection Products.¹⁶

4.3. APPLICATION OF PLANT PROTECTION PRODUCTS

58. Only specially trained persons and organisations that have obtained a certificate of competence may work with pesticides. Their training and knowledge shall be regularly complemented to avoid any risk in applying PPP.

Practical guidelines

Farmers and experts of agricultural service organisations should attend special courses on new registered products annually.

Assessment of harmful organisms and economically critical threshold in agricultural production should be carried out in each farm.

Once the PPP use is decided in a farm, every user shall be well acquainted with information

¹⁵ Register of PPP

⁶ Law of Plant Protection

¹⁶ Rules of trading and applying PPP

regarding each particular product:

- 7 recommended dose and concentration of spraying liquid;
- 7 spraying time or the stage of crop growth when PPP can be used;
- 7 selection of specific diseases, pests, and weeds;
- 7 timing of PPP application;
- 7 time lag between last application and harvesting;
- 7 time lag between last application and handwork;
- 7 all recommended safety measures should be noticed to avoid exposure of PPP;
- 7 emergency first aid.

Pesticides shall be chosen with consideration of the specific diseases, pests, and weeds and with the minimal harm to the environment. The use of selective PPP is recommended when possible.

The use of pesticides is not advisable when plants are in lack of water, because the effectiveness of PPP depends to a great extent on weather conditions.

The most of the pesticides should be applied early in the morning or in the evening in conditions of high air humidity and low air temperature.

The use of PPP is forbidden within the 10 m protection belts of wells, water supply zones, surface waters, and surface reclamation ditches⁵.

It is forbidden to treat the flowering plants with pesticides, except treatment of winter rape with pyrethroids, if it is done early in the morning before bees are in the field.

Bee-keepers shall be informed personally by the farmer about the place and time of field treatments at least in the radius of 2 km.

During the use of herbicides it is important to consider the direction of wind to protect the nearby sensitive crops from drift of herbicides.

If it is possible, application of PPP should be localised on the field edges or habitation sites of harmful organisms.

On large fields rates of pesticides shall be differentiated considering the intensity and location of diseases and pests. For crops cultivated in rows, if technologically possible, herbicides should be applied row by row, significantly reducing the amount of herbicides.

Mixing different pesticides or mixing pesticides with liquid fertilizers if it is technologically possible and if not against recommendations and instructions for use can reduce the times of treatment.

The PPP liquid for spraying should be prepared on the field according to the instructions of the distributing company.

The treated seed shall be cultivated into the soil very accurately to avoid poisoning of the wild animals.

The amount of liquid for spraying should be exactly calculated. Avoid excessive spraying of liquid. Empty containers shall be rinsed and the used water shall be added to spraying liquid.

Foam markers should be used to avoid double spraying.

Technological tracks should be established for cereals and rape in the fields.

59. All data about the applied plant protection products shall be registered in a special diary.

Additional information

Additional information about the system of recording is available at the Regional Plant Protection Inspectorate.

⁵ Law of Protection Belts

Practical guideline

All data about the plant protection treatment, i.e. crops, area, spraying time/date, agent and dose, should be adequately registered.

Doses for herbicide spraying should be determined only after registration of the specific type of weed in the field, as well as after assessment of the spread of dominant weed plants per square metre.

Before spraying against diseases it should be examined whether the economically critical thresholds are exceeded.

4.4. STORAGE OF PLANT PROTECTION PRODUCTS

60. Pesticides shall always be stored in a storage that is accessible only for the user. The storage has to be constructed to eliminate any risk for the environment. The PPP should be stored only in the original containers.

Practical guidelines

Storage for pesticides shall always be locked to prevent children and strangers from entering. All members of family should be informed about the purchased PPP.

The storage shall be fireproof.

Any leakage from damaged packages shall be collected in the storage, thus to eliminate any risk for the environment. Instructions for the disposal of empty containers are provided on the label of the specific product.

Containers shall not be burnt, buried in the ground or disposed of with other wastes.

Empty containers cannot be used for other purposes.

Pesticides shall not be stored together with food, drinks, and forage.

4.5. SPRAYERS

61. Only specially trained and qualified persons that possess a certificate shall work with pesticides on the fields.

Authorised service stations should be established in local municipalities for a regular control and maintenance of sprayers, and to issue certificates for their use.

Practical guidelines

The prospective user shall be very familiar with the functioning of each particular device, i.e. nozzle, spraying angles, and a proper distance to the crop.

Considerable attention shall be maintained during the whole treatment.

The amount of liquid spread on the square unit is very important to observe, and it differs for different crops and products.

Before farming season calibration of nozzles shall be carried out with clean water. The volume of the sprayed liquid should be measured by switching on the pump for 1 minute.

After use it is mandatory to wash the equipment. It should be carried out on the treated field, and washing water shall be spread on the same field.

Sprayers should be filled far enough from any watercourses or drainage systems with no risk for polluting through spilling.

Water for the sprayer should be available from a tank on the field of the treatment.

All instructions and safety measures shall be strictly observed.

4.6. ALTERNATIVE CROP PROTECTION METHODS

62. Agricultural production should be managed in a way to prevent plants from diseases, pests, and weeds in the due time thus decreasing the necessity for the use of pesticides.

All alternative plant protection methods should be practised.

Qualitative seed should be used on healthy soil to prevent a fast development and spread of diseases and to avoid unnecessary use of pesticides.

Crops most suitable to the specific soil type, topography, and the climatic conditions should be preferred.

A balanced crop rotation and an improvement of the growing conditions is an important prerequisite to limit the use of pesticides.

Crops should be chosen considering the level of their resistance to diseases, pests and weeds.

The work on the fields should be performed at the optimal time.

The treatments should not be implemented without a thorough analysis on their necessity.

The treatment should be based on the principle of thresholds. Non-use of chemicals should be considered as a priority. At least twice a week estimation of the field's condition should be performed. Lower rates of pesticides can be applied in early stages of development of weeds and diseases.

All treatments should be performed to consider the risk for environment pollution.

Biological PPP should be used whenever possible.

4.7. SAFETY MEASURES

63. All information about safety measures and emergency first aid must be available before starting work with PPP.

Practical guidelines

Farmers can obtain information about safety measures during the compulsory courses.

Instruction on the label should be read before opening a package or container. It is recommended to read it several times. All instructions and safety measures shall be observed.

All individual safety means and clothing should be obtained and used.

All family members should be informed about pesticide treatment time and place.

Detailed information about pesticide treatments shall be recorded in a journal.

5. WATER RESOURCES



5.1. INTRODUCTION

Agriculture is the main source of the river run-off pollution contributing nitrogen loads to the Gulf of Riga and the Baltic Sea. Also a considerable part of phosphorus loads is of an agricultural origin. The nutrient run-off causes pollution of surface and ground water with nitrates and contributes eutrofication or development of water plants, mainly algae. Thus, it decreases the water quality. Pollution from silo effluents, slurry and pesticides, is very dangerous for the water-bodies.

Table 16. Biological oxygen demand of pollution sources (mg/l)

Pollution source	BOD,mg/l
Treated municipal waste water	5 – 70
Untreated municipal waste water	300 – 400
Run-off from settlements	45 – 115
Agricultural run-off	5 – 190
Leakage from pig slurry storage	3100 – 3500
Pig slurry	20000 – 30000
Leakage from cattle slurry storage	2100 – 2300
Silage	50000 – 52000

Nutrient and other pollutant leakage with run-off depends from water balance. Deep percolation is typical for soil water balance in Latvia.

Water balance includes precipitation, evapotranspiration, run-off and water storage in the soil. Average precipitation in Latvia is 700 mm; evapotranspiration – 450 mm. Excess water causes run-off (about 250 mm in a normal year). In some years the soil water storage increases, in other years decreases, therefore run-off might be smaller or greater than the net precipitation. Total run-off consists of surface run-off, drainage run-off and flow from ground water. Water balance has temporal variations within a year. In the figure below the monthly net precipitation (run-off and water deficiency) is depicted for three regions of Latvia.

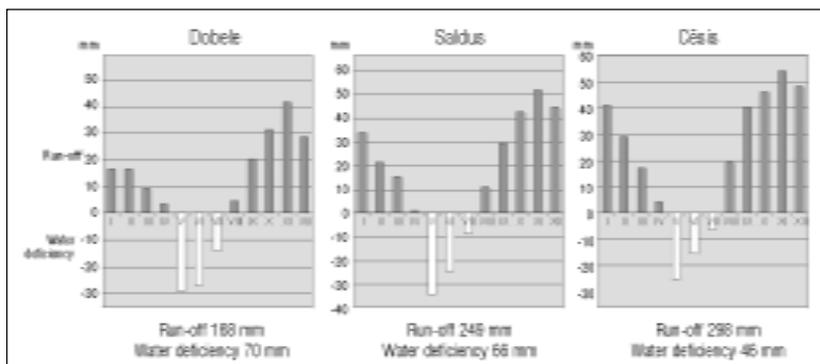


Figure 6. Run-off and water deficiency in different regions of Latvia

Leakage of the plant nutrients means the nutrient transport away from the crop root zone due to the water flow in soil. It is natural to all soils in Latvia, and considering the deep percolation most intensive leakage occurs during spring and autumn. Intensive agriculture, application of fertilizers, and land drainage increase the leakage of plant nutrients. Light (sandy) soils with low content of organic

matter and higher acidity have the highest leakage potential. During the water percolation through the soil many chemical elements are transported, and the amounts of elements depend on the buffering capacity of the soil. The evaluation of the environmental impact and agricultural considerations indicates that the leakage of nitrogen and phosphorus has the most negative impact.

5.2. MANAGEMENT OF THE WATER RESOURCES

In most cases, all human activities have impact on the water resources, i.e. water quantity and quality. Thus, restrictions on water use have been implemented for preservation and control of the water resources. 'Water use' relates to the operations fostering a decrease in the water quality or quantity characteristics.

64. All human activities regarding water use that have impact on the water resources, i.e. waste water treatment and discharge, water use for irrigation, construction of reservoirs, extraction of groundwater, etc., have to be examined. Water Use Permits must be received from the Regional Environmental Boards or Environmental State Assessment Board.

Practical guidelines

Water Use Permit is mandatory if

- 7 the use of surface water is more than $20 \text{ m}^3 \text{ day}^{-1}$;
- 7 the abstraction of groundwater exceeds $20 \text{ m}^3 \text{ day}^{-1}$ or extraction depth is more than 20 m;
- 7 the point discharge of waste water is more than $5 \text{ m}^3 \text{ day}^{-1}$;
- 7 the aforementioned limitations have not been exceeded, however an essential impact on the environment or water resources quality or quantity could appear.

5.3. DRAINAGE

Drainage is an important precondition for agricultural use of land. About 75–90 % of arable land in Latvia depending of crop conditions has imperfect drainage status. Moreover, drainage systems provide appropriate circumstances in the exploitation of roads, residential areas, forests, etc. Average drainage run-off is 210 mm in spring and autumn of a normal year. Of course, in wet years the need for land drainage might be considerably higher.

For stable and high yields most of the arable land in Latvia has to be drained with tile drains. Drainage construction is expensive. However, a regular maintenance and reparation of the drainage systems is cheaper to compare with reconstruction or renovation of damaged drainage systems.

The land reclamation systems relating to their use and ownership are as follows:

- 7 **state** land reclamation systems and structures: rivers, water reservoirs, dams, pump stations, floodgates, and other significant structures that are maintained by state land reclamation services;
- 7 **public** land reclamation systems and structures: main channels and hydro technical structures used for land drainage of several owners;
- 7 **private** land reclamation systems and structures: channels, subsurface drainage, drainage channels, interception channels, and structures used for land drainage of a single farm.

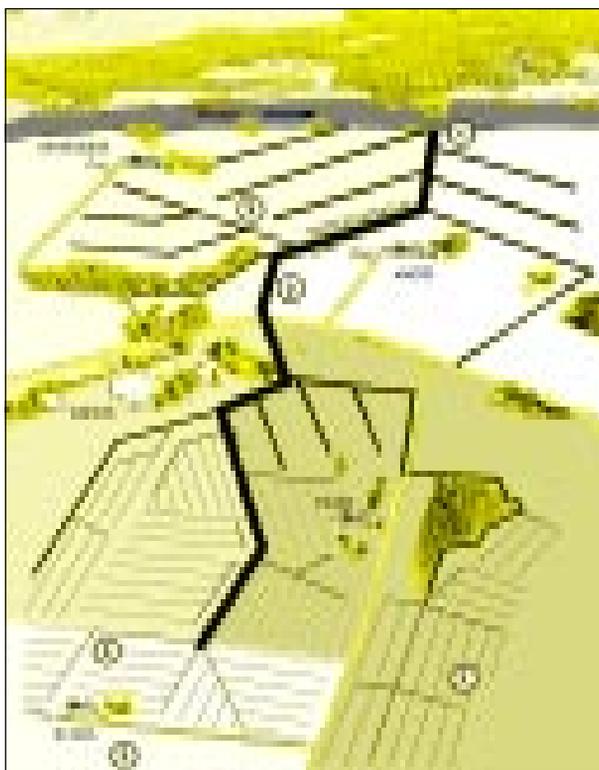


Figure 7. Types of land reclamation systems: 1 – state; 2 – public; 3 – private.

During the land privatisation a landowner has to receive a passport of the drainage systems with the Instructions on Maintenance of the Land Reclamation Systems and Structures.

65. The landowner (user) is responsible for a proper use and maintenance of the drainage systems in his ownership. The disposal of excess water to neighbouring land, if this action can have a negative impact on the natural drainage situation, is not allowed. The landowner (user) has a right to hold and use the stream flow on his land (except public rivers), if this action does not interfere with drainage of other ownership or cause the damage to other owners.¹⁷

Practical guidelines

The Drainage Associations shall be established for maintenance and repair of the public and private land reclamation systems and structures. The most common maintenance works in the drainage systems of farmland are following:

- 7 regular removal of the sediments and sludge from drainage chambers and filters. Sediments can enter pipe and clog the main lines of drainage. Drainage chambers should be covered with lid to protect from litter and prevent animals from falling in;
- 7 a supervision of the drained area should be performed every year after spring floods. Surface evidences of failure of tile drains (seepage of water, permanent wetness of the soil, water erosion holes) should be investigated to find damaged tile drains. Drainage outlets should be controlled every year after spring floods. Water seepage along the pipes and washout of soil has to be prevented, silt should be cleaned from the outlet. Drainage reparation should be carried out during dry season, when it is easy to excavate the trench in damaged drainage lines;
- 7 removal of sediments and litter from channel bed, cutting of grass, and reparation of the washouts in slopes of channels;
- 7 surface run-off control with proper soil management, land levelling and furrows for interception of run-off, installation of additional filters for surface water on drain lines.

Use of heavy machinery should be avoided during periods with high soil moisture conditions. Otherwise a compaction of soil, decrease of the water percolation through soil, and direct damage to the drainage lines could occur.

5.4. IRRIGATION

In Latvia the crop water needs are not covered by natural rainfall in dry summers or during dry periods in the summer. Water deficiency depends also from the plant available moisture in soil and groundwater table.

It is essential to evaluate the economic viability of irrigation considering the intensity of agricultural land use. Most common irrigated profitable crops in Latvia are vegetables, greenhouse crops, and in some cases pastures and orchards.

66. During irrigation surface run-off causing pollution of water sources and water leakage deeper than root zone should be avoided.

¹⁷ Law on Land Reclamation

Practical guidelines

Sandy soils and vegetables have the highest demand for irrigation. The net irrigation requirement in a normal year (frequency of occurrence is every second year) is 60–150 mm year⁻¹ (1 mm = 10 m³/ha). The exact irrigation requirement can be calculated taking into account crop rotation and the specific climatic region of Latvia.

Sprinkler irrigation is the most common irrigation method used in Latvia. According to the method irrigation water is applied several times during the vegetation period. Irrigation rate depends from soil and crop conditions. Recommended irrigation rates during the first stages of crop vegetation are 10–25 mm, but after crop cover is established – 20–40 mm. The upper limit of the irrigation rate could be recommended for the soils with greater moisture capacity – loam, clay, and in soils rich of organic matter.

High irrigation rates causing surface run-off or percolation of water in the deeper sub-soil should be avoided. Surface run-off might cause water erosion and loss of the soil. Water leakage to the sub-soil promotes nutrient leaching from plant root zone.

In favourable site conditions (low slopes, light soils, and sufficient water resources) subsurface irrigation with water table management (with control structures) is recommended. Drainage systems after construction of water level regulation structures can be used for subirrigation.

The drip irrigation and micro sprinklers are recommended in the greenhouses.

5.5. SOIL EROSION

Soil erosion is a natural phenomenon affecting the water quality always and everywhere. Agriculture like other human activities can increase the erosion. Plant nutrients (nitrogen, phosphorus) together with loosed soil particles cause eutrofication of the water sources. Sedimentation of soil particles threatens the spawn ground places of valuable fish species. Turbid water decreases the recreation value of the water sources. Water or wind can also cause erosion (see chapter 1.3.).

67 • In areas sensitive to wind erosion formation of large continuous fields should be avoided. Moreover, the woodland has to be preserved and shelterbelts have to be used to decrease the wind erosion.

Practical guidelines

In flat topography sites in Latvia the field size is not recommended larger than 20–60 ha, but in the areas with undulating topography – 10–30 ha. The optimal proportion between margins of the fields is from 1:3 to 1:5.

The shelterbelts contribute to the improvement of the microclimate by increasing of soil and air t°, and by preserving soil moisture that decreases evapotranspiration. Negative impact of the shelterbelts might be observed in spring due to the slower drying of the soil. Roots of the trees also hinder soil tillage close to the shelterbelts. However, the trees and bushes should be preserved wherever it is possible. Location of field borders, channels, roads, and farm buildings have to be considered in the design of the shelterbelts. The effect of the shelterbelts can be measured as a distance equal to 25–30 times average height of trees (250–300m). In the shelter belts trees and bushes shall be arranged in three rows with

distance between trees of 1,25–1,5 m, fast growing species of trees such as black alder should be combined with slow growing trees (oak, maple, ash). Moreover, shade resistant bushes shall be combined with trees to cover the soil and prevent weeds. The shelterbelts improve biodiversity in the rural areas and constitute the habitat for birds and valuable insects.

68. Water erosion by surface run-off should be avoided by ensuring that water from rainfall or snow melting can percolate in soil or in the drainage systems.

Practical guidelines

Good soil drainage and well maintained drainage systems such as filters and chambers for capture of the surface run-off can decrease erosion. Further surface drainage improvement through land smoothing and shaping decreases surface water flow. Furrows covered with grass are recommended for the interception of surface run-off. Black fallow has the highest erosion risk and is not recommended also from the farming viewpoint because bare soil without vegetation further increases the nutrient leaching.

Consequences of water erosion – run-off of soil particles into water sources might be reduced by the protection belts covered with vegetation (perennial grass, trees, and bushes). Uncultivated protection belts, at least 1,0–1,5 m wide, are recommended along drainage channels.

5.6. PROTECTION OF WATER RESOURCES

Protection belts

Protection belts are designed in certain land areas for protection of different objects from unacceptable outside impact, for their safe maintenance, and for prevention of possible side effects on the environment and human beings.

69. Law determines a list of territories as protection belts in the Baltic Sea and the Riga Gulf coastline and along the rivers and lakes, where landowners and users must follow regulations regarding the environmental protection.⁵

70. The construction of stores for animal feed (except existing hay storages), mineral fertilizers, plant protection products, fuel, oil, chemical substances, wood materials, and storage's of other materials and substances is not allowed in the protection belts of dunes, rivers and lakes.⁵

⁵ Law of Protection Belts

Law restricts the construction of new buildings or objects in the protected areas. The construction of manure storages in the protection belts of dunes, rivers, and lakes also should be avoided.

Table 17. The width of the protection belts in the rural areas*

Place	Width of protection belts, m
The Baltic Sea and Riga Gulf coast line (measured from the point where vegetation begins)	300
Dunes of the Baltic Sea and Riga Gulf coast line	Full width of dunes, but not less than 300 m
Daugava, Gauja from Lejasciens to the sea, lakes more than 1000 ha	500
Gauja from headwater to Lejasciens, Lielupe, Venta and other rivers longer than 100 km, lakes of the size from 101 to 1000 ha,	300
Rivers with the length of 25–100 km, lakes of the size from 25 to 100 ha	100
Rivers with the length of 10–25 km, lakes of the size from 10 to 25 ha	50
Rivers with the length up to the 10 km, lakes of the size up to 10 ha	10
Streams and lakes with floodplain	Not less than the width of the floodplain

* the protection belts are established along both banks of the river

71. Clean out is prohibited in the belt of dunes as well as in an area of 50 m along rivers and lakes. The land reclamation is not allowed in the belt of dunes and in the area of 10 m along rivers and lakes without a permission of the environmental authorities.⁵

The clean cuts along rivers and lakes could cause soil erosion, nutrient leakage, and pollution of water-bodies. The construction of the land reclamation systems could change the water regime and have an influence on landscape and biological diversity.

72. The placement and construction of buildings, water supply facilities, water level and other hydro technical structures, bathing places, landing stages for boats and ships, as well as application of fertilizers and plant protection products are prohibited in the protection belt of 10 m along rivers and lakes.⁵

Practical guidelines

Following restrictions are recommended as additional measures for the environmental protection in the agricultural lands, not already prescribed by Law on Protection Belts:

- 7 application of fertilizers and plant protection products along the drainage channels, drainage chambers and surface run-off filters;
- 7 application of fertilizers in the flooded areas with the forecasted spring flood probability of up to 25 % (flooding risk once in 4 years). Application of fertilizers in such areas is allowed only during vegetation period when nutrient uptake of crops is high.

5.7. WETLANDS

A wetland is a permanently or periodically water-saturated or covered area. Wetland consists of marshes, mires, bogs, shallow lakes, river coastlines, and the sea coastline. Wetland reclamation for agricultural use is problematic both from the technical and the economical viewpoint.

73. Wetlands that play key environmental role by contributing to flow regulation, removal of plant nutrients, and preserving of biodiversity should be protected and restored.

Practical guidelines

Due to the poor natural drainage in many wet areas of the agricultural land in Latvia construction of ponds and water reservoirs for self-purification of run-off is recommended. Simple hydrotechnical structures can be used to regulate water level and to promote restoration of wetlands. It is also useful to create the sedimentation basins in the drainage channels through deepening and widening of some parts of the channel bed.

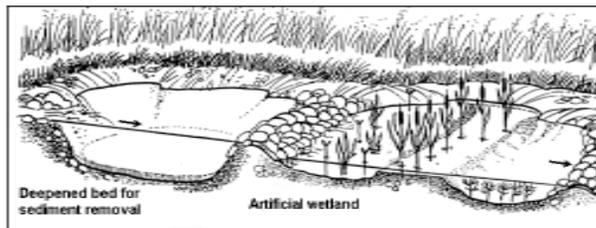


Figure 8. Sedimentation basin with artificial wetland

In the sedimentation basins soil particles transported by run-off get settled and water quality is improved through plants uptake of nutrients. Sedimentation basins have to be cleaned from sediments once in 3-5 years.

5.8. DRINKING WATER SUPPLY

Generally open wells and artesian wells are used for drinking water supply in farms. Open well has a depth of 4-8 m and the shallow groundwater is used for abstraction of the drinking water. The shallow groundwater is poorly protected against pollution. The water quality depends on hydrogeological and sanitary conditions as well as on the design of the well. The main pollutants of the groundwater are slurry, wastewater and agricultural chemicals. Sandy soil's and other light soils with high percolation of water are most sensitive against pollution. One of the most important drinking water quality characteristics is nitrate nitrogen that can have an agricultural origin and is harmful for human health.

74. The concentration of nitrate in drinking water should not exceed 50 mg/l NO₃

Practical guidelines

When finding the place for an open well it is necessary to take into account the depth and the quantitative availability of water as well as the location of the animal barns, manure storage, and waste water treatment facilities. Location closer than 25 m to such structures is not recommended.

During construction of wells connections between concrete rings have to be filled and the seepage of surface water around the top ring of well has to be prevented. For these purposes densely packed clay has to be used. The well should be covered with a lid.

The pollution and sediments in the bottom of the well decrease quality of the drinking water. Removal of sediments and cleaning of the open well is recommended once in 10–20 years.

An artesian well is recommended to secure a stable and good quality drinking water supply. Drinking water from artesian wells is extracted from deeper ground water aquifers. The quality of water in artesian wells is considerably higher, although the construction costs of wells are high as well.

75. There should be a 30 – 50 m sanitary protection zone around an artesian well.

5.9. WASTEWATER IN FARMS

With the improvement of living standards in the farms the water supply and sewage systems will be introduced. It will increase the water use for human consumption and the discharge of wastewater causing the problem of wastewater treatment in farms.

Practical guidelines

The amount of the produced wastewater depends on the number of inhabitants and the level of water use in a farm. The wastewater output corresponding each water use pattern is presented in the following table.

Table 18. Wastewater discharge per capita, day⁻¹ in the farm

Type of housing	Water discharge per capita per day, litres
Living houses with water supply lines and a sewage system without bathroom	80–100
Living houses with water supply lines and a sewage system with bathroom, local water heating	150
Living houses with water supply lines and a sewage system with bathroom, central hot water supply	300

76. Wastewater from farms should be treated before the discharge in the watercourses.

A full-scale wastewater treatment system includes both mechanical and biological treatment.

Practical guidelines

A single household mechanical wastewater treatment system with a septic tank is recommended for settlement of larger solids and sediments. The concrete rings or other concrete structures are used for the construction of the septic tank. The volume of the septic tank must be at least 3 times larger than the wastewater discharge calculated according to the number of inhabitants and the water use per person. For discharge of up to 1 m³ per day one chamber tank is necessary. If discharge is greater, the septic tank should be divided in two sections. Recommended volume of the first section is $\frac{3}{4}$ of the total volume. Solids must be periodically pumped out of the tank depending on the load.

77 • After the mechanical treatment in appropriate conditions biological treatment is recommended as a secondary treatment.

Practical guidelines

Simple and cheap methods for nutrient removal and recalculation are recommended for wastewater biological treatment in small systems. After a treatment in a septic tank the wastewater could be further cleaned in sand filters, filtering chambers, filtration trenches, and soil filters with perforated pipes.

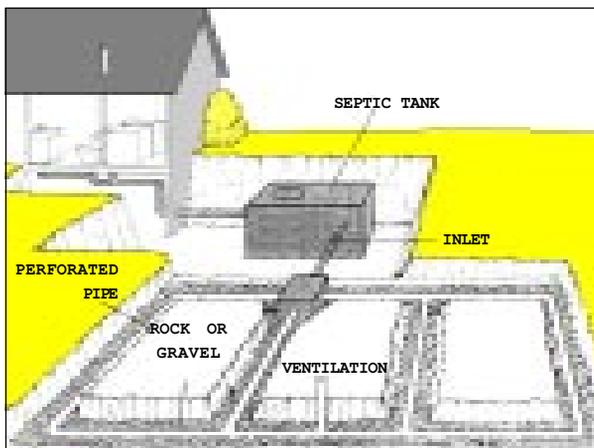


Figure 9. Wastewater treatment with infiltration in soil

The use of above mentioned treatment systems is recommended in light soils (sand, sandy loam, loam), if the ground water level is deeper than 1,5 m below the soil surface.

Vegetation filters (artificial wetlands) can be used for biological treatment. The approximate size of the vegetation filter for a single family farm should be 20–30 m².

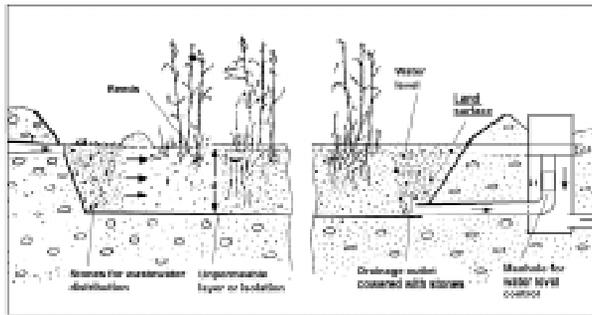
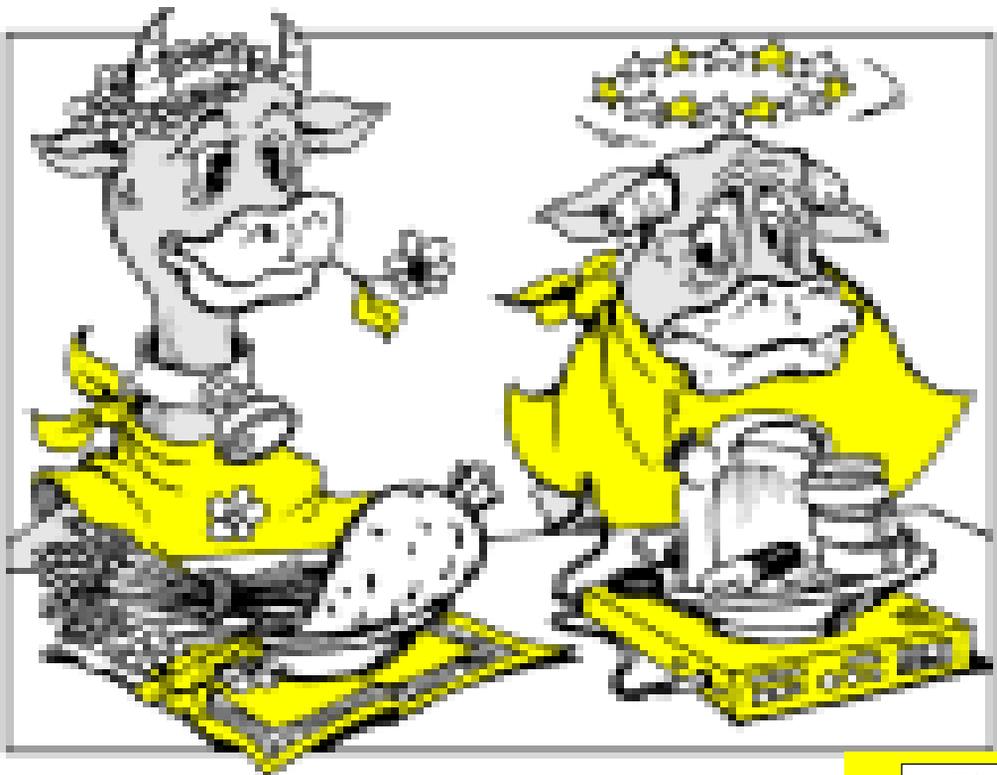


Figure 10. Vegetation filter for wastewater treatment

6. AGRICULTURAL SYSTEMS



6.1. TYPES AND SELECTION OF AGRICULTURAL SYSTEMS

Agricultural system – set of sectors and methods as well as technological tools where with soil as the main production resource crops, animals, fruits and vegetables are produced. Composition of sectors can be different from farm to farm. Agricultural systems in Europe are divided into following according to technologies used and their relationships to other systems.

Agricultural systems are closely linked to economical, environmental, and social issues. Solution of these issues is the most important prerequisite to a sustainable agricultural system. Philosophy and education, economic and environmental conditions of each individual define preference to the agricultural system.

78. The following main criteria should be used for the evaluation of agricultural systems:

- 7 high production level and quality;
- 7 production costs are reasonable to keep production competitive;
- 7 reasonable stability of production from year to year, by sector, farm and field;
- 7 friendly relationships to the main nature resources (soil, water, plants, animals, landscape) and their conservation for future generations;
- 7 the chosen specialization and production structure maintain flexibility – ability to react on changes in supply and demand in the market;
- 7 equilibrium among economical, ecological and social requirements in a long – run in order to develop sustainable agricultural systems.

Sustainable agriculture should also cope with social issues in rural areas:

- 7 employment;
- 7 development of infrastructure and preservation and development of cultural heritage;
- 7 development of roads and communications.

In organising agricultural production decisions taken by local municipalities should also be taken into account. This is supported by paragraph 8 of the Law for Territorial planning.

Understanding of sustainable agriculture is not related to just five – ten year's period. Preservation of national, regional and global nature sources is of greatest importance. Therefore fulfilment of the *Code of Good Agricultural Practice* is one of the prerequisites for future generation to live in undegraded and non-polluted environment.

Table 19. Division of agricultural systems

Agricultural systems	Characteristics of agricultural systems
Sustainable	Intensive production of competitive products with friendly relations to the environment. Very often term " <i>integrated systems</i> " is used due to the application of chemicals, preventative and biological means. Farms are multi sector producers.
Conventional	Intensive production of competitive products with the emphasis on the concentration of production and deep specialization. Mineral fertilizers and chemicals are widely used in crop production. This type of systems still has a limited use in Latvia. It may leave a negative impact on the environment.
Biological	Production of competitive produce is possible. Environmentally friendly methods of production. Mineral fertilizers and pesticides are not used for crops. Certification of technologies is required for the product quality control. Deliver the products to a special market

6.2. SUSTAINABLE AGRICULTURAL SYSTEMS

Sustainable (integrated) agricultural systems are characterised by multi sector production when crop production always goes hand-in-hand with animal production. The following is required for intensive production of competitive produce under sustainable agricultural systems:

- 7 wide scope of crops. Perennial grassland is required for animal production. Legumes are to make nitrogen balance positive. Intermediate crops are used in specialised crop schemes to minimise negative consequences of monoculture and nitrogen leakage;
- 7 compost, manure, and green manure crops in combination with mineral fertilizers are used for the maintenance of soil fertility. Fertiliser rates are based on nutrient balance calculations avoiding groundlessly high fertilizer rates. Fertilisers should gain high yields without harm to the environment;
- 7 prophylactic and biological protection means shall be used as widely as possible, by limiting the use of chemicals. Crop ability to inhibit spread of weeds is to be of great importance as well as high quality mechanical treatment for the prevention of weeds;
- 7 animal production shall promote rational and protection use of natural grassland, pastures, and areas undergoing erosion. Feeding must be in accordance to productivity of stock, manure storage and handling rules that shall be applied in order to minimise pollution. The number of animals should correspond to the area of the arable land of the farm;
- 7 protection and preservation of water basins, landscape, biodiversity and other elements of the environment shall be taken into account in farm planning. Ecological and social aspects have to be accounted for besides the economic aspect of the business;
- 7 while the overall certification of technologies is not yet performed, conformity of produce shall be checked against requirements.

79. Sustainable agriculture should become a part of state agrarian policy.

Sustainable agricultural systems is the most perspective kind of farming widely used in rural areas finding integrated solution to economical, social, and environmental issues.

80. Fulfilment of all rules of the Code of GAP should be determined by the adhesion to sustainable agriculture. Besides a farm should have a farm management plan (crop rotation and fertilising plan) and accounting according to law.

6.3. CONVENTIONAL AGRICULTURAL SYSTEMS

They are characterised by deep specialisation of production that allows intensifying production and minimizing production costs. Mineral fertilizers and pesticides are widely used in crop production and horticulture. Very often animal production is not a part of the farm's business, therefore it is difficult to include perennial grassland in crop rotation. Such grassland is most important to maintain the fertility of soil. Compost and manure are not utilised for the reproduction of the soil. Predominance of certain crops in crop rotation is widespread therefore very common is to plan monoculture by using high fertilizer rates and chemicals.

As a result an impact risk of environmental pollution is often observed.

In this type of farms economic values play a major role, but protection of environment is only concern in order to follow legislative regulations. Individual interests in farming are most important, ethics of farming and farming as the "way of living" is regarded as out-dated. Agriculture is just a rural business. Large influence from advance in research and technology development. Large farms and concentration of land, processing, capital and labour. Generally, this type of farming does not correspond to the principles of sustainable development.

6.4. BIOLOGICAL AGRICULTURE SYSTEMS

Biological (ecological, organic, bio-organic, bio-dynamic farming) agriculture is a type of production to solve issue of the negative impact of agriculture on the environment and product quality. In these systems natural substances and minerals replace mineral fertilizers, pesticides, drugs, and growth stimulators.

Lower outputs are common. But viable economic return can be obtained when the produce is sold in special markets for higher prices.

Objectives of biological agriculture are:

- 7 to produce high quality products in a sufficient quantity and preserve their natural features;
- 7 to minimise environmental pollution and maintain biological diversity and long term soil fertility;
- 7 to create living conditions for food producers which would satisfy their needs, guarantee safe working environment, allow to get income, give satisfaction of work, and maintain life's harmony to nature.

Biological agriculture creates conditions for the development of natural ecosystems and most fully provides sustainability of agricultural systems. All biological agriculture systems have common requirements.

81. Crop rotation should be taken into account consistently in the biological agriculture systems. Cultivation providing maintenance of soil fertility should be applied. Organic fertilizers and well-prepared compost can be used for increasing and maintaining soil fertility. Maximum benefit should be gained from micro-organisms: growing nitrogen fixative plants, reproduction of nutrients in soil to more available forms for plants by using micro-organisms, earth – worms and plant roots. A balanced harmony between crop production and animal husbandry should be created.

Possible losses of nitrogen from soil should be minimized by biological agriculture systems by fertilizing soil with organic fertilizers, by utilizing nitrogen fixative plants (legumes) and stimulating the action of micro-organisms in soil. This can be achieved by less intensive cultivation techniques, correct time intervals, inclusion of intermediary crops, and application of organic fertilizer.

If mineral fertilizers are not used for a longer time, the balance of nutrients in soil might be negative. Biological production shall be planned to ensure a long time nutrient balance and regular soil analysis should be carried out. Using fertilizer kinds that are allowed for biological agriculture can compensate limiting nutrients.

82. Control of weeds, pests and diseases should be carried out only with prophylactic, mechanical or biological means. Natural ability to inhibit the spread of weeds by crop should be used as widely as possible.

Production techniques are approximated to nature processes. Local landscape, biodiversity of species and protection and preservation of other environmental elements shall be taken into account in the farm planning. Besides economic criteria, environmental and rural social issues are to be highly considered.

83. Animals should be kept according to their natural needs (pastures, exercise, light etc.). Purchased fertilizer and feed should not exceed 10% of the total amount. Stocking rate should not exceed 1,7 livestock units per hectare agriculture land.

Competitive biological agricultural systems use recent advances in research. This allows producing high quality agricultural products. However, production level is lower than in conventional and sustainable farming. Developing biological agriculture, in order to preserve the total volume of production, the area of arable land has to be increased. Expertise for processing and marketing of biological products is essential among farmers due to the limited level of the development of processing plants.

One of the types of biological agriculture is biodynamic agriculture. Rhythms of planets, primarily Earth and Moon are taken into account. Specific methods are applied.

There were 200 biological farms in 1998 producing vegetables, grain, seasonings, fruits, bee products, and animal products. Farms are certified, e.g. production process is checked thoroughly against the standards of biological agriculture.

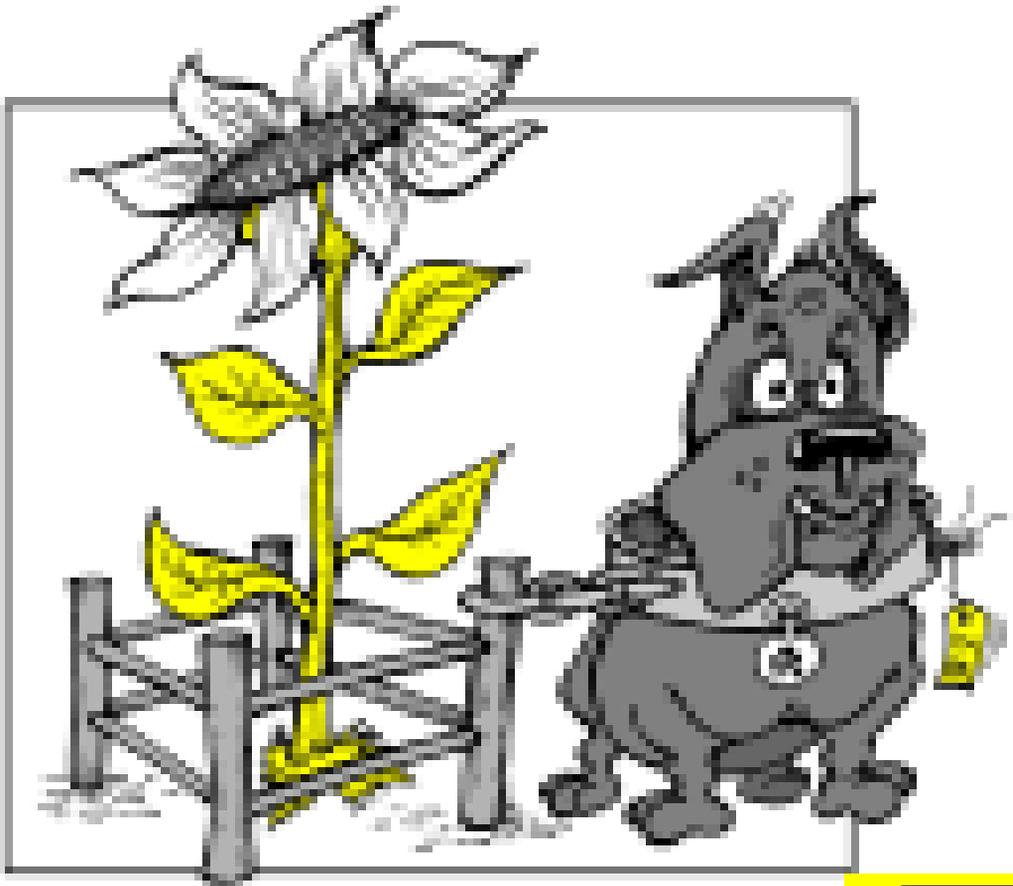
84. Following criteria should be applied to qualify for biological agriculture:
7 the farm must be certified;
7 the farm must have management plans (crop rotation and land fertilization plan) and accounting according to the law.

Biological agriculture methods are sustainable systems. Therefore, all biological farms should fulfil requirements of sustainable agriculture regarding product quality and technologies of production and their impact on the environment.

Latvian Standards for the certification of biological agriculture determine requirements for production, processing, marketing, and documentation of agricultural produce. Production and certification of biological agricultural products are voluntary. Control is obligatory part of certification. Advanced requirements have to be fulfilled to get internationally accepted certificates (*OICA, Demeter etc.*). It is required to become a member of biological agriculture organization, to attend theoretical and practical

training, to restructure the farm according to standards of biological agriculture, and to implement biological agriculture technologies. Certificates are issued by Certification Committee of the Latvian Association of Organizations of Biological Agriculture.

7. BIOLOGICAL DIVERSITY AND LANDSCAPE



7.1. INTRODUCTION

Biological diversity means the diversity of living organisms on land and in waters. It includes diversity both within and between the species. A relation of a mutual interdependence exists between species in the nature and in various ecosystems. Even a loss of one species may cause undesirable changes in the whole system. Biological diversity increases the stability and the total productivity of any system, therefore it is an important precondition for a sustainable agriculture. The necessity to secure and maintain the maximal biological diversity is recognised world wide as well as in the legislation of the Republic of Latvia.¹⁸ As the biological diversity is possible only on a diverse landscape, it is very important that the landscape itself is protected. The intellectual and material culture in Latvia has also developed concurrently with its cultural landscape. Therefore, it is important to preserve the landscape, the cultural and historic heritage as a precondition for a sustainable development. A real threat to the present, still relatively rich natural environment and landscape of Latvia appears with the growing intensification of the economic activity. The main threats are:

- 7 contamination of the environment;
- 7 destruction and denudation of the habitat for wild species;
- 7 the interruption or destruction of the migration routes of animals;
- 7 the destruction or degradation of the aesthetic landscape;
- 7 the destruction or mutilation of items of cultural or historic heritage.

For Latvia it is equally important to protect its own natural resources as well as to be ready to fulfil the conditions required by international law and conventions. The agricultural policy of the EU envisages promotion and stimulation of the agricultural use of land in a manner that is compatible with the preservation and protection of the landscape and biodiversity.

The rural landscape is the most important habitat, as well as a protection and sustenance of the various natural life forms of plants, animals, insects, and different microorganisms. Therefore it is very important that the development of a strategy for a sustainable agriculture would include the maintenance and preservation of the most diverse natural environment. It must begin at the level of the each individual farmer and land user. Every homestead is unique, not duplicated and not repeating, and each has its place in the totality of the biore. These individual households should be (but often are not) at the forefront in determining conditions for the preservation and protection of the most diverse biological landscape.

7.2. SECURING OF BIOLOGICAL DIVERSITY AND LANDSCAPE PROTECTION

The following preconditions must be fulfilled to protect the biological diversity and landscape:

85. Land use on farms should be diversified.

¹⁸ Environmental Protection Law, Law on Specially Protected Nature Territories, Law on Protection Spaces and Biotopes (draft).

The ecological principle that soil has a "right" to a crop cover should be followed. It means that in the natural conditions of Latvian climatic biotype the soil is covered with diverse vegetation during the growing season. It fosters soil self-renewal and protects it from erosion. This principle is not adequately followed in agricultural production. The soil is frequently exposed without any vegetation for long time periods (for example, fields left in rotational fallow, after potato or root crop harvest, etc.) or the same crop is continually cultivated that depletes the soil. However, the negative impact can be avoided by introducing green manure or vegetative intercrop as well as a proper crop rotation sequences.

86. Habitat of wild species should be protected.

On a farm various species of wild animals and plants can always inhabit areas not used for cultivation of crops. Roadsides, drainage ditches, balks, wetlands, meadows and pastures, a yard, a streambank, and a pond – all provide habitat of a diverse wild life and thus they should be protected.

87. Protection of species should be guaranteed.

The protection of wild as well as domesticated and cultivated species is one of the crucial measures for the securing of biological diversity. The necessity to protect species is prescribed by the Environmental Protection Policy Plan of the Republic of Latvia.¹⁹ Protection of species and the environment can be implemented in every farm and rural household. It is important to recognise the significance of protection of the environmental quality.

88. Historical and cultural heritage should be protected and maintained.

Over centuries Latvia has experienced changes in population numbers, density, distribution and in economic activity. These changes and their intensity initiated diverse impact on the biome and the natural landscape. Forests have been felled, fields and pastures cultivated, orchards and gardens erected. Our ancestors thus significantly contributed to the present day landscape that is unique and will never be repeated. The landscape is the witness and the record of the history of the Latvian people and cultural heritage.

Practical guidelines

The yard and the orchard.

The farmhouse, the yard, and the orchard constitute a united system that exists as a part of a larger natural environment. With simple means it is possible to create appropriate conditions for the life of small mammals, reptiles, birds, and insects within the presence of human activity:

- 7 avoid the use of blacktop concrete and other watertight material because they poison the lane way. Gravel paths are very good to provide a dry and ecologically friendly yard;
- 7 green the walls of your buildings;
- 7 set up bird-cages and try to save old and hollow trees;
- 7 create compost piles of the organic waste – it provides a valuable fertilizer and a habitat for many small animals;
- 7 create hedges of appropriate local species;
- 7 try to preserve traditionally locally grown fruit trees, vegetables or decorative plant varieties;

¹⁹ Environmental Protection Policy Plan for Latvia; R., 1995.

- 7 prevent the spreading of rapidly reproducing introduced foreign species (*Heracleum mantgazzianum*, *Impatiens glandulifera* and others);
- 7 cultivate rich wild flower lawns instead of the mowed lawns where possible.

Fields.

Maintain a singular environment, where the dominant plant species is regularly replaced. The number of species on fields is limited, therefore considering the biological diversity environmentally friendly activities are of great importance:

- 7 avoid too early tilling of an overly moist soil that could result in soil compaction, thus threatening the survival of soil inhabiting organisms;
- 7 avoid often and regular use of cutter type soil tillage equipment that could injure and kill soil organisms;
- 7 supply soil with the organic matter, thus stimulating activities of earthworms;
- 7 perform soil tillage as early as possible to allow the wild animals to find their habitat;
- 7 mow as late as possible to avoid killing of young animals;
- 7 leave boundaries between fields;
- 7 carry out harvesting from the middle of the field outwards the sides, and provide the combine harvesters with equipment for alarming animals.

Meadows and pastures.

Both are dominant elements of the rural landscape. Biological diversity is larger there than in fields, particularly in natural meadows and pastures. In order to protect these original ecosystems and their characteristic large biological diversity:

- 7 do not fertilize and do not perform any other maintenance works in the natural meadows with unproductive soils during their blooming;
- 7 do not start a premature tilling of an overly moist soil that might facilitate soil compaction thus threatening the habitat of soil inhabiting organisms;
- 7 save and preserve single large trees and shrubs in the fields, in particular if they are fruit or berries producing species e.g. wild apple trees, pear trees, sweet briar, oak and other species that supply wildlife with food and shelter;
- 7 preserve natural pastures for long term pasturing and haying to avoid frequent ploughing;
- 7 leave some patches of pastures not tilled;
- 7 mow parts of sloughs and floodplains by hand where it is impossible to use machinery;
- 7 start anew a low intensity pasturing on old pasture lands even if it is not economically profitable, such as juniper covered hillsides, forest pasturing, areas and floodplains of lakes or rivers;
- 7 pasture on the hillsides, lake shore slopes, steeper river valleys, infertile sandy areas and calcareous soil areas by keeping few sheep for this purpose;
- 7 do not allow overgrazing and maintain optimal balance between the herd size and the capacity of the available land area and conditions;
- 7 start haying from the middle of the field and outwards the side, and equip machinery with devices to scare away animals that often hide in the not mowed part of the field.

Roadsides and ditches:

- 7 plant hedges, trees, shrubs and alleys along the roadsides. Use locally grown food and seed bearing plants that provide habitat for animals;
- 7 leave single natural trees, shrubs and tall succulent vegetation patches along the roadsides where planting is not feasible;
- 7 prevent mowing of roadside ditches before the young animals have grown, i.e. end of July;
- 7 do not burn the dry grasses of previous seasons in the spring.

The aquatic ecosystems.

The aquatic ecosystems are standing or running waters like sloughs, ponds, lakes as well as ditches, streams, creeks, and rivers. They contribute to the beauty of the landscape, and provide a habitat for many plants, animal, insect, and microorganism species. In order to preserve and to maintain biological diversity and landscape:

7 create ponds and plant its banks with trees, shrubs and grass;

7 save and improve the natural vegetation along the banks of lakes, streams, and rivers;

7 do not allow any unwarranted regulation of stream and river beds.

Try to leave the natural flow of rivers and streams unaltered as it has developed in a balance with the whole environment. If possible, attempt to repair already damaged natural channels and restore the biological diversity of these biotas as a vital part of the biologically and geomorphologically developed total natural environment.

Appendix 1**Calculation of fertilizer plan for one field on your own farm**

Fertilizer needs per ton yield for different crops are roughly will be assessed according to Table 9. The amount of manure and plant nutrients in it will be assessed from Table 8. See example on Table 12.

Calculation	Amount	Plant nutrients, kg		
		N	P ₂ O ₅	K ₂ O
1 Norm* (need) per ha (Table 10)				
2 Norm (need) per ___ ha (line 1 x ___ ha)				
3 Manure from _____ (Table 9)				
4 Effective fertilizing value of the manure, % (estimate dependent on application time and technique, etc.)				
5 Effective fertilizing value of the manure, kg (line 3 x line 4 / 100)				
6 Difference, to be applied as mineral fertilizer (line 2 - line 5)				
7 Plant nutrient content in used fertilizers _____				
8 _____ to comply with the rest need of nitrogen (line 6 / line 7 x 100), kg				
9 _____ to comply with the rest need of P ₂ O ₅ (line 6 / line 7 x 100), kg				
10 _____ to comply with the rest need of K ₂ O (line 6 / line 7 x 100), kg				

*The norm is determined from the standard normative (Table 9), adjusted for field history - here under the fertilizing effect of previous crop, pH of the soil, soil type, soil analyses - here under N_{min} analyses, and for the climate in the region.

This table is prepared for use of different types of mineral fertilizers, as there usually are used more than one type.

Appendix 2**Calculation of number of Livestock Units and livestock density on your own farm**

Housing system	Manure type	IU per animal	Number of animals	IU in total
1	2	3	4	5=3x4
Sow with 18 piglets to 20 kg weight				
Solid floor	Solid manure	0,21		
Slaughter pigs produced , 20 – 100 kg live weight				
Slotted floor	Slurry/washing	0,10		
	Periodical flush	0,09		
Solid floor	Slurry	0,12		
	Solid manure	0,15		
Dairy cow , milk yield 3500 – 5000 kg per year				
Tie up, solid floor	Solid manure	0,6		
	Slurry	0,5		
Dairy cow , milk yield 5000 – 7000 kg per year				
Tie up, solid floor	Solid manure	0,8		
	Slurry	0,6		
Dairy cow , milk yield above 7000 kg per year				
Tie up, solid floor	Solid manure	1,0		
	Slurry	0,8		
Young stock (cattle), up to 6 month old				
Tie up, solid floor	Solid manure	0,14		
	Slurry	0,11		
Tie up, deep litter	Solid manure	0,18		
Heifer , 6 to 24 month				
Tie up, solid floor	Solid manure	0,37		
	Slurry	0,33		
Tie up, deep litter	Solid manure	0,41		
Bulls , from 6 months up to 450 kg live weight (26 months)				
Tie up, solid floor	Solid manure	0,52		
	Slurry	0,45		
Slotted floor	Slurry	0,45		
Free, deep litter	Solid manure	0,63		
Horse				
Tie up, solid floor	Solid manure	0,4		
Sheep				
Deep litter	Solid manure	0,07		
Hens				
Deep litter	Solid manure	0,01		
Battery	Slurry	0,01		
TOTAL NUMBER OF LIVESTOCK UNITS				
Ha of agricultural land				
LIVESTOCK DENSITY, IU per ha agricultural land				

Appendix 3**Calculation of the required manure storage capacity on your own farm**

Housing system sistāra	Manure type	Tonnes manure produced per animal per year	Number of animals	Tonnes manure intotal
1	2	3	4	5=3x4
Sow with 18 piglets to 20 kg weight				
Solidfloor	Solidmanure	46		
Slaughter pigs, 20 – 100 kg live weight				
Slottedfloor	Slurrywashing	87		
	Periodical flush	34		
Solidfloor	Slurry	36		
	Solidmanure	26		
Dairy cow, milk yield 3500 – 5000 kg per year				
Tieup, solidfloor	Solidmanure	13,0		
	Slurry	22,0		
Dairy cow, milk yield 5000 – 7000 kg per year				
Tieup, solidfloor	Solidmanure	15,5		
	Slurry	27,0		
Dairy cow, milk yield above 7000 kg per year				
Tieup, solidfloor	Solidmanure	17,5		
	Slurry	30,0		
Young stock (cattle), up to 6 month old				
Tieup, solidfloor	Solidmanure	26		
	Slurry	60		
Tieup, deep litter	Solidmanure	40		
Heifer, 6 to 24 month				
Tieup, solidfloor	Solidmanure	67		
	Slurry	15,0		
Tieup, deep litter	Solidmanure	90		
Bulls from 6 months up to 450 kg live weight (26 months)				
Tieup, solidfloor	Solidmanure	11,1		
	Slurry	20,5		
Slottedfloor	Slurry	20,5		
Free, deep litter	Solidmanure	15,0		
Horse				
Tieup, solidfloor	Solidmanure	80		
Sheep				
Deep litter	Solidmanure	09		
Hens				
Deep litter	Solidmanure	01		
Battery	Slurry	01		
Additional effluents				
From silage clamps, m ³				
From milking parlours, m ³				
From rainfall, m ³				
From washing of stables, m ³				
From other sources, m ³				
TOTAL AMOUNT OF ANIMAL MANURE PER YEAR, TONNES				
Months storage capacity				
REQUIRED SIZE OF MANURE STORAGE, M³				

LEGISLATION IN AGRO - ENVIRONMENTAL SECTOR IN LATVIA

21.06.1991	Law on Land Use and Survey
06.08.1991	Environmental Protection Law
02.03.1993	Law on Specially Protected Nature Territories
30.03.1993	Law on Hazardous Waste
20.04.1993	Law on Land Reclamation
05.02.1995	Instruction on Register Order of Plant Protection Products in Latvia
30.06.1995	Regulations on Trade and Use of Plant Protection Products
10.08.1995	Building Law
14.09.1995	Law on Restitution of Ownership's Rights on Land in Especially Protected Nature Objects
14.09.1995	Natural Resources Tax Law
02.05.1996	Law on Subsoil
20.06.1996	Order of Adaptation of the Norms of Nature Resource Tax – Regulations of the Cabinet of Ministers
24.10.1996	Law on Agriculture
03.12.1996	Conception Latvian rural development policy – Accepted by Cabinet of Ministers
05.02.1997	Law on Protection Belts
01.04.1997	General Building Regulations, Regulations of the Cabinet of Ministers
22.04.1997	Water Use Permit Regulations, Regulations of the Cabinet of Ministers
12.08.1997	Regulations of Council of Ministers about permits for Land Use Type Transformation
21.10.1997	Regulations and General Provisions for the Protection and Use of Specially Protected Nature Territories – Regulations of the Cabinet of Ministers
01.11.1997	Regulations on the Use of Sewage Sludge in Soil Fertilizing and Development of Territories – Regulations of the Cabinet of Ministers
1997	List on Record of P Protection Products in Latvia, year 1995 – 2005
1997	Regulations of Council of Ministers about Transformation Agriculture Land to Forestland
27.01.1998	Latvian National Conception of Territory Planning, Accepted by Cabinet of Ministers
14.02.1998	Territory Planning Regulations of Council of Ministers No. 62
14.10.1998	Law on Environmental Impact Assessments
15.10.1998	Law about Territory Planning
17.12.1998	Plant Protection Law
1998	Standards of Biological Agriculture Certificates. Association of Latvian Biological Agriculture institutions, Riga, p.28.
1998	Country Development Program
1998	Pedigree record normative documents, 1 volume. Ministry of Agriculture
07.09.1999	Regulation on Distribution, Storage and Use of Plant Protection Products
05.10.1999	Regulation on Register Order of Plant Protection Products
Draft in 1999	Law on Protection of Species and Biotopes
	Law on Fertilizers
	Law on Veterinary

