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Conservation agriculture, organic farming and GM crops in Ukraine

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1. Conservation Agriculture (CA)

The notions about CA in Ukraine are rather wide. The notion is considered as a number of **measures and concrete agromethods** directed to the soils protection and renewal of their fertility. In this work we have given the preference to a wide interpretation of CA, but still paid more attention to the soil tillage. Among the **measures** the following should be marked:

- the system of state measures (**SSM**) (elaboration of the programme on lands' protection and support of hydrotechnical, chemical and agroforest reclamation, elaboration and introduction of ecological norms and laws, including the limits on the pressure of machine-tractor units (MTU) onto the soil, improving the ecological training of specialists, activation of mass-media);
- contour – ameliorative soil- protective organization of the agricultural territory (**COT**);
- improving of the structure of agricultural lands (**SAL**) at the expense of the transition of a part of ploughland, represented by the degraded and not productive soil, into the meadows, pastures or under afforestation in order to increase the stability of an agrolandscape.

Among the concrete agromethods the most important are:

- different kinds of minimization of tillage, including routing of MTU;
- anti-erosion agrotechnical methods;
- biologization of agriculture (introducing of short crop rotations and their saturation with grass and crops of continuous sowing, mulching for the improvement of moisture balance, plowing of plant remnants to improve carbon balance, application of sapropel, peat, other organic combinations of local origin, biopreparations). Let's briefly scrutinize the enumerated measures.

SSM. After almost 10-year period of crisis in the agrarian sphere the reviving of soil protection is to a certain extent-taking place. The national programme of soil protection is elaborated and introduced into the Supreme Soviet. The programme provides financing of a number of soil-protective measures from 2006. The programme of renewal of reclaimed and drained lands is also being considered (about 2.0 mln hec among 5,5 mln hec of total number of such lands needs to be reconstructed and renovated). The Law code (2001), Law of lands' protection (2003), Law on control for their rational use (2003) are put in force. Probably, several important ecological norms, including the standard of the permissible pressure of MTU into the soil, will be adopted this year. Several new monographs and course-books on CA are published. Undoubtedly, all these measures will further the improvement of CA in the country.

COT. It is being introduced in Ukraine since the end of 80-ies of the last century. It offers a gradual transition from the rectilinear organization of fields to the contour one and carrying out of technological operations, the prohibition on the cultivation of clean-cultivated crops on the slopes steeper than 3^0 , the substitution of the mouldboard tillage by various types of antierosion one (subsurface, chisel and others), the local application of mineral fertilizers, using diverse antierosion constructions and forest stripes. COT reduces erosion in 2-5 times in arid conditions, it adds 100-150 m³/hec of moisture and 1,0-1,5t/hec of grain, increases the diversity of plants and animals, gradually forms cultural agrolandscape. COT is introduced in Ukraine on the area of 1,5 mln hec of the ploughland. There are model basic farms in Kiev, Kharkiv and Donetsk regions. The whole Obukhovskiy district of Kiev region (the total area of about 75 thous. hec) is also the basic one.

SAL. By force of dominating of the fertile soils and favorable climatic conditions the ploughland of the lands in Ukraine has become one of the highest in the world, which predetermined a number of unfavorable ecological consequences (erosion, other types of degradation). After many years of discussion it was decided to reduce considerably the ploughland and thus to improve the correlation between the stable and unstable elements of the landscape. The process of withdrawal (leading) of the not productive and degraded lands from the ploughland was begun. The lands located on the slopes steeper than 3° (their area is 3.7 mln hec), ploughed flood lands in the (1.0 mln hec), the lands situated near cattle – farms (1,05 mln hec), contaminated by radionuclides (0,05 mln hec), not productive lands (about 3,0 mln hec) are subject to withdrawal. It's planned to withdraw 8,8 mln hec (the total area of the ploughland – about 32 mln hec) during 10 years. Even after such a considerable reducing ploughland in Ukraine (58%) is still the highest in Europe. Among the measures directed to CA and as a consequence, to Sustainable Agriculture, reducing of ploughland is the most significant measure. It is exactly the measure, which should introduce sustainability into the agriculture from the ecological points of view.

Concrete Agromethods. Within CA in Ukraine the following methods of minimalization tillage are used: refusal from every year ploughing and its substitution by other methods of primary tillage (chisel, subsurface), decreasing the depth of primary tillage, combination of pre-sowing tillage's with application of fertilizers and sowing, reducing the number of inter-row loosening and their substitution by chemical tillage's, routing moving of machine–tractor units, decreasing the total area of compacted soils, refusal from the tillage's at all and sowing into an untilled soil immediately, the fulfillment of a number of technological operations is supposed to be carried out during one pass of a tractor.

Besides, other methods of CA are being used: saturation of crop-rotations with perennial grasses, crops of the complete sowing at the expense of reducing of clean-cultivated crops, fragmentation and leaving on the field portions of plant remnants (mulching) or their plowing into the upper layers of the soil, using of various agrotechnical methods of prevention water and wind erosion.

The main parameters of measures connected with CA are given in the table 1. Last years on account of the absence of stocktaking same data are tentative (is marked *).

Excluding last 10-12 years crisis in agriculture a considerable amount of works belonging to CA and contributing to Sustainable Agriculture was being done. Before 1991 almost all ameliorative works, creation and maintaining of antierosion constructions were done at the expense of state budget. Today the sources means are being diversified. In view the adoption of new laws on lands protection, the adoption of a number of state programmes on soil protection and the resumption of the financing from the budget are expected. The land reform, introduction of private property on land demand the elaboration of a new order of planning, fulfillment and monitoring of the work contributing to introduction of CA.

But, unfortunately, new approaches in the agricultural practice in Ukraine are being introduced too slowly. At the same time the scientific substantiations allow to predict wide possibilities for introducing CA. It first of all concerns minimal and zero tillage's, more effective use of plant remnants (in the purposes of mulching and as an additional source of organic carbon), biologization of different types, development of contour-ameliorative organization of fields and technologies. Ecological and economical advantages of the enumerated components will be considered at the analysis of the database of the collected experiments.

Table 1 – The volume of executed/ planned works in Ukraine belonging to SA

Name of works	Units of measures	Volumes of works	
		executed (for 8-10 years or per year)	planned in the National program 2006-2015 (average annual) data
Contour-ameliorative soil protective organization of the territory	mln hec (for former years)	1,0	0,25
Withdrawal of not productive and degraded lands out of ploughland	-“-	1,72	0,7
<i>Introduction of biologization elements in agriculture:</i>	t/hec		
- application of organic fertilizers	(per year)	2-3	2,5-3,5
- additional ploughing of plant remnants	-“-	1,0-1,1*	1,2-1,3
- application of sapropel	thous.t(per year)	50*	9,0-10,0
- using peat for organic and organomineral fertilizers	mln t (per year)	1,0	1,5
- producing of bacterial fertilizers	mln of hectare portions(per year)	0,20-0,25	0,3-0,4
<i>State support of reclamation:</i>			
- liming	thous. hec per year	50-60	60-70
- gypsuming	-“-	10-15	30-40
- renaturalization of drained lands	-“-	2-3	5-6
- reconstruction of drained lands	-“-	5-7*	30-35
- cultivated and technical works on the drained lands	-“-	30-40*	100-120
- deep ameliorative loosening of the gleyic soils	-“-	5,0-7,0*	10-15
- construction of irrigational systems	-“-	-	8,0
- reconstruction of irrigational systems	-“-	no data	100-110
- construction of drainage	-“-	-	6
<i>Different types of antierosional tillage and creation of forest-protective plantations:</i>			
- sowing by antierosional seeder	mln hec (per year)	1,75	2,0-2,5
- chiseling of ploughland	-“-	2,0-2,5	3,0-3,5
- stripe placing of crops	thous.hec (per year)	50-60	80-100
- creation of antierosional forest plantations	\$ mln	200 (for former years)	20-30
<i>Different types of minimal tillage and mulching:</i>			
- surface tillage for winter grain crops	mln hec (per year)	4,5-5,0	7-8
- using of combined soil-tilled, fertilizing and sowing machines	mln hec	1,0*	2,0-3,0
- minimal tillage (except winter grain crops)	-“-	2,0-2,5*	4,0-4,5*
- zero tillage	-“-	0,5-0,6*	2,5-3,0*
- route moving of MTU at cultivation of clean-cultivated crops	-“-	1,4-1,5*	2,0-2,5*
- mulching	-“-	0,5*	1,0-1,5*

2. Organic farming (OF)

Ukraine as for its soil-climatic conditions, geographical position in the center of Europe and long standing agricultural traditions, is quite potential to produce organic agricultural production for its export and consumption at the home market.

About 70 farms in different regions of Ukraine have been already drawn in produce of organic production. Part of them has even an experience of its export mainly with the help of companies, as, for example, “Ukragrofin”, which has sufficient knowledge’s of market and foreign trade.

Ukraine is increasingly getting noted in the international market of organic products. For the area of agricultural lands (239.5 thous. hec) the country already occupies the 16 place in the world among more than 100 countries, leaving behind such leaders of organic movement as: Hungary, Denmark, Netherlands, Sweden, Switzerland (tables 2,3). But at the same time a portion of certificated areas among the total quantity of agricultural land of the country is less than 0.6 % while in Czech Republic, Estonia and Hungary it is 5.0; 3.0 and 1.7 % correspondingly.

Table 2 – The area of certificated organic farms in the Eastern Europe and the countries of the former Soviet Union by the beginning of 2004

Country	Area, hec
Ukraine	239542
Czech Republic	235136
Hungary	103672
Poland	53515
Slovakia	49999
Romania	40000
Kazakhstan	36882
Estonia	30552
Latvia	16934
Yugoslavia	15200
Slovenia	15000
Lithuania	8780
Russia	5276
Azerbaijan	2540
Bosnia and Herzegovina	1113
Bulgaria	500
Croatia	120
Total around the world	24 070 010

Table 3 – The quantity of certificated organic farms of the Eastern Europe and the countries of the former Soviet Union by the beginning of 2004

Country	Quantity, pieces
Poland	1977
Romania	1200
Slovenia	1150
Hungary	1116
Czech Republic	654
Estonia	583
Lithuania	393
Latvia	350
Azerbaijan	285
Bosnia and Herzegovina	92
Slovakia	84
Ukraine	69
Bulgaria	50
Croatia	18
Kazakhstan	1
Total around the world	462 475

Taking into account the potential of agriculture in Ukraine it can be surely and optimistically to prognose that in 3-4 years Ukraine can enter the club of the first “ten” of the world producers of organic fertilizers. But it is possible only in the conditions of the development of innovation technologies of organic agriculture, own system of certification and marketing of organic products.

The export amount of organic production in Ukraine is only from 2.0 to 15.0 thous. tons per year inspite of really astonishing areas.

The quality (of grain crops, leguminous plants, oil crops, berries, nuts, etc) is rather highly estimated by the users in Europe, North America and other regions of the planet. But the market of organic fertilizers in Ukraine itself is, unfortunately, on the initial stage. There are objective institutional – legal, financial and economic and social-psychological problems, which create obstacles and demand consideration and solvation. They are:

- the absence of legislative grounds, the basic law, in particular, as for organic agriculture and certification of organic production;
- the absence of infrastructures, first of all certificating institutions, associations of the producers of organic production and the corresponding trade net;
- a very weak integration into international structures to facilitate the access to the foreign markets;
- lack of information-consulting providing and competent advise services;
- lack of ecological thinking and education; innovational passivity of managing structures; a high level of poverty of population.

To determine and realize the following steps it is advisable to form a wide partnership, which will unite the interests and demands of different parties concerned in Ukraine and to enlist them to active cooperation:

- agricultural producers, farms and their association, in particular;
- private consulting companies and certificating institutions;
- organizations of consumers;
- scientific institutions and public organizations.

The development of organic agriculture and creative of the corresponding system of certification in Ukraine will demand specialists of high qualification, effective institutions and modern legislative base, which will take into account world and European tendencies. In the context it can be advisable and very useful to use the rich experience and instruments, which Ukraine may adopt from the International Federation of Organic Agriculture IFOAM, the European Union and leading countries.

3. Genetically Modified plants (GMO)

On 20.01 in 2000 in Montreal (Canada) 110 states signed Kartakhen record on biosafety – the first international document, which provides the creation of the mechanisms of control for GMO. On 25.06 in 2002 the record was ratified by the countries-members of EU. Ukraine ratified this record on 12/09 in 2002. By the beginning of 2003 39 states had ratified this record.

In 2002 GMO were officially cultivated in 16 countries. “Officially” means that GM-sorts were entered in the state registers of agricultural plants, tested and allowed for their commercial distribution.

In 1996 the sowing areas of GMO were about 2 mln hec, in 2002 their number increased to 59 mln hec.

The main sowing areas under GMO are in the USA, Argentina, Brazil, Australia, and China. But China where till recently GM-technologies were considered as perspective ones, after

the joining the World Trade Organization, took diametrically opposite side, because it has become evident that it is more difficult to guarantee the safety of GM-technologies than it was considered.

Recently the countries – members of EU have announced about the prolongation of the moratorium on the registration of new GMO for 4 years. This provoked negative reaction of the USA - the leading producer of GMO. According to expert estimation the volumes of the global market of GMO have a clearly determined tendency for the stable increasing. The companies - producers of GMO began to enter into Ukrainian market at the beginning of 80-ies. One of the leader of GMO –industry-company “Monsanto” started his activity in Ukraine with field investigations introducing the soil tillage technologies with using the methods of plants and seeds protection of own production in the farms of Sumy, Donetsk and Dnipropetrovsk regions. In 1989 this company introduced the herbicide project on the area of about 100 hec in Sumy region. In 1992 it sold its GMO –production on the sum of \$ 32 mln to Ukraine. In 1993 these sums reached to \$ 50 mln and the experimental areas – to 25 demonstrative farms. In 1994 100% of the production of the total cost of \$ 10 mln was realized in Donetsk region. 1995- additional selling in Donetsk region (\$ 14 mln), projects in Vinnitsa and Dnipropetrovsk regions. In 1996 the company expanded the net of distributors. It’s well known, than field tests of GM – plants were carried out in Pivne, Volyn, Kyiv (in particular in the villages of Berezan, Nemishaeve) and Cherkasy (village Dzendzelivka) region (the data from in the official site of “Monsanto” WWW.monsanto.com.ua). All this superprofitable activity of transnational companies in Ukraine is illegal. Till now there is no official point of view on the problem, which is reflected in opposite positions of the supporter and opponents of the using of the GMO, and the absence of strategic vision and corresponding scientific argumentation only postpone the decision.

As for safety of elaboration and using of GMO in Ukraine officially the resolution of the Cabinet of Minister “On the approval of the temporary order of importation, state testing, registration and using of trans-genetic sorts of plants in Ukraine” was adopted in 1998. In 2001 the draft law “ On the state system of bio-safety while carrying out genetic-engineering activity” was introduced to consider by the Supreme Soviet. The draft law “On the state system of safety at creating, testing and practical using of genetically modified organisms” is being considered.

One of the main warnings of unsanctioned using of GMO in Ukraine is the real danger of cross-pollination of GMO by the objects of natural genetically non-modified plants because of inobservance of spatial isolation and the absence of strict and effective control.

As a result the national value of Ukraine – its genetic resources, which are the leading factors of further safety in the sphere of selection and producing of raw – materials and food, may occur in danger. In the Center of genetic resources of in Ukraine (Kharkiv) 38200 authentic home samples of 280 crops and 300 wild species which are of great interest for the leading selection centers and companies, are collected and concentrated.

Besides, home ecologically and genetically pure sorts can be genetically contaminated, their protective, export and competitive force can be lost.

At the time certain investigation on genetic engineering are being carried out in Ukraine. In the Institute of Plant-growing of UAAS (Kharkiv) the directions of investigations on genetically modified starch amiloze and amilozpectin kind of maize done by the mutation of 5, 6, 9 chromosomes are being treated. Such work is of great interest for home pharmacy, food industry, production of thermo utilized. The examination has proved that these works correspond the level of biological, technological and national safety.

The first national hybrid of technical maize was created.

The extremely perspective are the works on the optimization of carbohydrate composition of peas at the expense of K-gene on the ground of mutation in 7 chromosomes. It is, first of all, easily assimilated protein of peas and optimization of nutrient protein balance. The sorts are created where are of great demand on the home and foreign market. They significantly widen the seed expansions and export possibilities of Ukraine.

Thus, in the nearest future, Ukraine should clarify the GMO problem, treat the criteria of expedient of conducting of scientific investigations on there aspects, involve monitoring and control in selection works, connected with GMO. The necessary measure of prolonged activity should become the introduction of complete information of customer- of selection GMO – elaboration to the Institute of sorts examination (Kyiv) as for the procedure of “alien” genes, nature and methods of identification.

Brief analysis of the information collected in the Ukraine

The materials, collected by us, allow to propose some innovation approaches to improvement of (1) tillage technology, (2) fertilizers, and also (3) in development of ecologically clean agriculture.

In the beginning for the best understanding of the material, conclusions and proposals we shall characterize briefly the natural conditions of the country. The area of Ukraine is 603670 km². From west to east the territory length is 1300 km, from north to the south - 900 km. In respect of the geology it is mainly southwest part of Russian platform. The climate - moderately continental, except for the southern coast of Crimea, where it is subtropical Mediterranean. On the continental part the rainfall changes from 300-350 mm in the south and southeast up to 700-1200 mm - in northwest and western parts. Humidifying factor (ratio of the rainfall to evaporation) changes from 0,3-0,4 up to 1,7-2,0 accordingly. That is why there are large variety of the soils in Ukraine from arid solonetzic chestnut soils to hydromorphic soddy podzolic gleysolic soils and bog. Parent rock - is basically moraine sediments of ancient glaciation, and also loess and loessial loam. Texture is accordingly sandy (clayey-sandy) and loam. In the soil cover various chernozems are dominate (60 %), further - in the various measure podzolic, gleysolic, auto- and hydromorphic soils.

The chernozems has high natural (on the variants of the experiments without fertilizers) fertility (winter wheat up to 2,5-3,0 t/hect; barley - up to 2,5 t/hect; corn on the grain - up to 3,5 t/hect; sugar beet - up to 25 t/hect), others soils are much poorer. At fertilizer application (effective fertility) on the background of high (real) technology the yield increase on 20-30 % and above. On the most part of the country such factories as the contamination, insufficient culture of agriculture and adverse humidifying mode do not allow to realize significant soil potential.

Alongside with high fertility soils in the soil cover are present about 2 mln. hect solonetz and solonetzic, about 8 mln. hect acid, more than 10 mln. hect (approximate data) eroded, about 0,5 mln. ha polluted (radionuclids and heavy metals) soils.

Taking into account the large variety of natural conditions and structure of crops the technologies of their cultivation were zonal at all times, dated to the basic natural zones - Polissiya, Forest-Steppe and Steppe. Just as the innovation improvement of the technologies following from the collection material are considered.

1. The perfection of the tillage technologies.

The beginning of the active experimentation in the tillage data from the end of XIX to the beginning of XX centuries, when in many regions of country the agricultural experimental stations were open. Today in each administrative regions (sum total is 25) such stations are functioned. They carry out tens of stationary long-term experiments. Their results are generalized in the books (Popov F.A., 1969; Gordiyenko V.P. and oth., 1998) and numerous articles. During these years the system of tillage undergo various changes, and quite often they became not sequent of long-term experiments, but followed to conjuncture and fashion. So was with deep plowing tillage per 30-s' years of the last century, when at support of party bodies it introduced everywhere without the account of the soil and climatic factors and requirements of plants. So was in 70-80's years with unmouldboard system.

Today in Ukraine dominate the so-called combined system of tillage, which includes cultivation by a plough on the enough large depth under fallow or clean-cultivated crops and is

combined with the entering of manure. For other crops of the crop rotation the different depth subsurface, chisel or disks tillage is used. In the zones of the raised humidifying more often is used the plowing tillage, in the zones of insufficient humidifying subsurface loosening is used. Soil protection tillage is applied about on 30-40% of arable land in Polessiye, on 40-50% - in Forrest-Steppe and 60-70 % - in Steppe.

The main defects of the conventional system are power inputs, low ecological safety shown in various kinds of soil degradation (erosion, overcompaction, destruction of structure, humus losses etc.) and, above all, low efficiency.

During last 30-40 years (although very slowly) some approaches to modernization of tillage are developed:

- various kinds of minimalization (decrease of depth of the primary tillage, combination and reduction of tillage number, replacement of the plough by other tools);
- zero tillage;
- mulching;
- routing movement of machine-tractor units (MTU) with the purpose of decreasing of the compaction area of the field;
- introduction of the national standard on the permissible load of MTU on the soil.

Further we shall consider the results of concrete experiments on tillage included in base.

Various kinds of minimalization of tillage.

In Ukraine there are significant potential opportunities for essential increase of the areas with the minimal and zero tillage. On the basis of comparison of the parameters of equilibrium and optimum bulk density for the most of the soils of the country in the work (Medvedev V.V., Lyndina T.E., 2001) is established, that the minimal technology (mainly replacement plowing tillage on subsurface and decreasing of number of inter-row loosening) can be applied on 11.0 mln. hec, and zero tillage - on 5.5 mln. hec (at 30.0 mln. hec arable lands). The zero technology promotes soil fertility preservation (the parameters of penetration resistance and structural were better), economy of fuel in 2.0 times, reduced labour inputs for tillage on 67%, that as a whole enables to lower direct expenses for getting of crop production on 22-45 of % (Medvedev V.V., Lyndina T.E., Pashenko V.F., Dorozko I.M., 1999).

In the work (Malienko A.M., Majronovski A.E., Kolomiets V.N., 1992) was shown that the unmouldboard loosening of soddy podzolic soil with leaving remains of preceding crops prevents overcompaction of arable layer, counteracts soil crust formation on the soil surface, reduces evaporation.

In the work (Lyndina T.E., 2000) minimal subsurface tillage of the chernozem on the 10-12 cm deep within 3-4 years has resulted in differentiation of arable layer by bulk density and other properties on two parts: top - friable and bottom - dense. The growth of roots in depth has worsened; the yield of sugar beet, peas and winter wheat has decreased. For corn the deterioration was not marked. It is possible to improve distribution of roots and to remove negative influence of overcompaction by realization plowing or combined tillage. Last, combining plowing tillage under sugar beet and shallow subsurface tillage under other crops is recommended for adoption in industry.

In the work (Litvinenko V.V., 1980) on chernozems typical at cultivation of the winter wheat the advantage of superficial (disk) tillage is discovered in droughty year, in moist year - better there was the plough. The efficiency of fertilizers was a little bit higher for plowing tillage. The fertilizers have shown the obvious tendency to increased use at their even incorporation to the layer of 0-30 cm and moderate compaction.

In a number of the modeling experiments which have been carried out in the microfield conditions with use of mathematical methods of planning (Lyndina T.E., 1992), set various parameters of bulk density, structural structure, mineral nutrition, depth of fertilizers application and study their influence on growth both development of roots and yield. The received results are used for creation of optimum model of root layer, finding - out of regularities of growth of roots and underground weight depending on various combinations and factors, and also formation the agronomical demands for tools and tillage technologies. The most interesting conclusions are those: optimum bulk density for development of roots and crop is moderate (is not higher than 1.30-1.35 g/cm³), the fertilizers are better for entering on the middle or in the bottom part of the arable layer. The degree of soil crumbling (structural composition) in layer, where seeds are placed, also concern to the factors rendering significant influence on the yield. The efficiency of N and P is regulated by soil density and humidity, K - does not depend on density practically.

The original diphase tillage is proposed at cultivation of the potatoes on soddy podzolic soils with light texture, overcompacted in underseed layer (Golodniy I.M., 1991). Last has a negative effect for roots formation in the spring. With the purpose of elimination of this defect the primary tillage put off till the spring (in autumn only disking) and realize by subsurface tool after appearance of shoots on the depth of overcompacted layer (23-25 cm). The trustworthy increases in yield of the potatoes, and on other data (not included in base) also of corn and oats are received. There is reason to assume, that such tillage will be expedient on all soils having overcompaction in subsurface horizon.

In experience (Lyndina T.E., Sendetskaya O.A., 1998) was investigated influence of mulching on agrophysical, biological properties and yield. The complex positive action of this method on preservation of the moisture, activization of microbiological activity, increase of mineral fertilizers efficiency, essential (on 38-46%) increase of the grain of barley yield is determined. It is a pity, that such well-known and effective method (it is difficulty to name it innovation) practically does not find application in the country, on which most part in particular water mode is the most problematic factor.

In the long-term experiment (Malienko A.M., Majronovski A.E., Kolomiets V.N., 1992 a. oth.) on the background of unmouldboard and mouldboard tillage the influence of the plant remains was studied. Remaining on the soil surface plant remains at unmouldboard tillage promote improvement of physical soil properties, reducing density of the top layer, accelerate appearance of shoots, that has favorable effect especially on the small-seed crops.

In the experiment (Glushenko L.D., Doroshenko L.D., Savchenko V.G., Bilanovych O.L., 2004) was studied the influence of permanent shallow subsurface tillage under all crops of crop rotation (winter wheat, corn, sugar beet and others). It turned out, that in the conditions of fertile chernozems and the high culture of agriculture it is possible to refuse of deep plowing tillage. Thus the satisfactory yield and recoument of the investigated fertilizer systems (especially for sugar beet) are received. The biological system (without application of mineral fertilizers) has allowed saving up to 50 % of mineral fertilizers.

At the same time on the less fertile dark-chestnut soils and in irrigation the best results has shown traditional plowing and especially combined tillage (Malyarchuk M.P., Kryshopa

P.A., Markovska O.E., 2002). Last provided the highest yield and economy of material inputs. Permanent shallow subsurface tillage increased the weedeness of the fields.

In the series of experiments (Lyndina T.E, 2003; Sheyko S.N., 2003; Ptashenko A.V., 2002) was studied efficiency of diminution of operations number at cultivation of clean-cultivated crops of sunflower, corn and potatoes - on chernozems typical. Instead of usual 14-16 - 6-8 operations. It was established, that the diminution of passes number at the expense of unification or refusal of the part of the operations essentially improves economic results and does not result in decrease in yield.

At the same time on the soils with superficial deposition of compacted gleying horizon (brown podzolic noncalcareous gley of Before- and Zaccarphattya) periodic deep loosening with simultaneous application of lime and fertilizers raises their fertility. The truth, such method is enough expensive and use not often (Gavryk P.O., Trop L.S., 1974).

For decreasing of influence of machine-tractor units on soil at crop cultivation the routing of their movement on fixed ruts is proved. It reduces the total compaction area at 1.7-2.7 time at realization of all necessary technological operations (Medvedev V.V., Nazarova D.I., Vorona L.I., Slobodyuk P.I., Pashenko V.F., 1989). The improvement of soil physical properties, crops and yield condition are simultaneously marked, and last it is steadily found out during a number years for several crops. The routing can be widely introduced at cultivation of clean-cultivated crops, and at some constructive changes of units (it is necessary to equalize or to make their width multiple with the width of capture of a seeder, which gets out as base) - at cultivation of even seeding of crops.

With the purpose of the establishment of the permissible load level in the field experiment was tested the influence of passes (from 0 up to 10 within the limits of 0-150 kPa) of various wheel tractors on compaction of chernozem and soddy podzolic soils. Criterion of the latter was changes of bulk density, air content, structure and other soil characteristics after pass of the wheels. Permissible load was differentiated depending on texture and humidity at the moment of pass. The established levels are 20-40 and 40-60 kPa accordingly in spring and in autumn at humidity, which was equal 0.9 field water capacity. At downturn of humidifying the permissible load levels are increased. The work results are submitted for the statement as the standards, which the manufacturers of machine-tractor units and its users should be guided by. At introduction of standards the importance of the problem of soil overcompaction will decrease essentially, and, probably, it will be to remove from the agenda at all (Lyndina T., Tsybulko V., Yevtenko V., Medvedev V., 2004).

So, the experiments on soil tillage collected in the database testify to considerable resources of its improvement on the basis of use mainly various minimalization methods. Reduction the operations number, their depths or even complete refusal of tillage in general can have spreading on the significant part of our country. At the same time and the traditional tillage methods, probably, will have spreading in the nearest and future prospect, and in some regions (overmoistening, gleying, overcompacting, weeding and others) - they are not have alternative.

Such method as mulching and routing of movement of machine-tractor units are rather perspective, but unfortunately unpopular.

In the database pay on itself attention the researches having the purpose to develop optimum model of tilled layer. On the basis of these works can be formulated agronomical requirements to tools and technologies of fundamentally new type, which are capable to reproduce them in real conditions and by that to achieve the maximal efficiency from tillage and simultaneously to protect soil from unfavorable influences.

2. Perfection of fertilizing technologies

If in Western Europe chemicalization of agriculture began since 70 years of XIX century, in Ukraine - only middle of 60 years of XX century. For 25 next years as the result of active development of chemicalization the average level of mineral fertilizers application has achieved 148 to 1990, under winter wheat 170; corn on the grain 207, sugar beet of 432 kg of active ingredient on hectare. At the same time the system of agrochemical service and the material base were created, the agrochemical certification of soils was expand, the numerous stationary experiments were setup. As the result the yield of all crops (up to 1t of the grain/head per one year) has increased essentially, and on the contents of the macroelements mobile forms the simple reproduction of fertility is achieved (or rather the almost self-supporting nutrient balance).

In the scientific plan the following questions were decided: the zone systems of fertilizers application in various crop rotations were elaborated, ways of their application assisting increase of ratios of fertilizers utilization were developed, the ways of deficiency decreasing of biogenic elements balance were proposed, new forms of complex fertilizers are developed, the potentialities of fertilizers application made on the basis of local raw material (of peat, sapropel, phosphorites, industrial waste) are substantiated.

Unfortunately, the crisis in the agrarian sector began in 1991 and which has not finished till now, has rejected the country back: application quantity of fertilizers are sharply declined (till 20-30 kg / hec), the technologies have become simpler, the soil fertility and almost twice yield has decreased.

In connection with radical change of structure and organization in agriculture, with the change of the format of ownership on soil, occurrence numerous and practically needy land users, which unable to realize modern (expensive) technologies, a number of new problems has appeared. It is difficult to decide them in short term. In the context of our work among them most important are:

- The results of many scientific experiments, which were setup in former times and counting on the high level of chemicalization, today are not claimed;
- The standard industrial fertilizers having extremely high cost and insufficient recoupment because of low culture of agriculture do not to be in requisition of the land users and are got very badly.

In these conditions the new ways of the fertilizers application ensured their high recoupment (for example, feed in the spring during crops growth instead of autumn, as a matter of fact reserve application), new less ballast fertilizers forms, fertilizers prepared on the basis of local (and therefore cheap) raw material are rather perspective.

But the experiments with such subjects were setup a little.

Therefore database on fertilizers, made by us, contains obviously insufficiently innovation moments.

Let's consider the results of some concrete experiments directed on the improvement of existing fertilizers system.

In the work (Batsula O.O., Skrylnyk E.V., Doroshenko Yu.L., 2004) the attempt to find the ways of regulation of plant remains and manure humification was made. It turned out, that the deep entering of organic fertilizers on depth 25-35 cm essentially slows down the mineralization processes and, on the contrary, considerably raises the ratio of their humification. Two important practical conclusions are made. In traditional agriculture system the manure it is

necessary to bring in at plowing under clean-cultivated crops; in alternative (organic) system the complete utilization and the deep entering of the plant remains can essentially reduce need for manure for creation of no deficient balance of organic substance.

Similar conclusions are postulated in the works (Chujan I.V., 1990), where in the modeling microfield experiments is corroborated, that manure entering in the middle or bottom part of arable layer and its moderate compacting intensified ameliorating influence on soils properties (especially decompaction and improvement of structure). The largest effect from manure use was observed at the combined tillage technology. By results of these works the new design of the tool for more verified manure entering (on the determined depth with simultaneous additional moderate compaction) was substantiated.

It is interesting the experiments on study the efficiency of organic and mineral fertilizers in irrigation conditions, especially in long-term experiments (Philip'ev I.D., Gamayunova V.V., Vasilenko N.I., 1990; Gamayunova V.V., 2001; Philip'ev I.D. and others, 2003; Gamayunova V.V., 2003). In irrigation conditions the fertilizers have high recouplement and influence favorable on yield quality. At the same time, in these conditions the nitric fertilizers were characterized high descending migratory ability for limits of root layer. The fertilizers system based on moderate doses of mineral fertilizers in the combination with the plant remains use is represented optimum to the authors.

In experiment (Truskavets'kyi R.S., 2003), where used local amelioration technology of acid soddy podzolic soil providing local application of the organic-mineral complex (peat, lime, NPK) during primary and presowing cultivation, the significant economic, power benefit and ecological effect are received. The technology contains novelty and is recommended for Polissya. Practically such positive effect was achieved (Melnichuk A.O., 2005), when manure used instead of peat.

The organic-mineral fertilizers system in overmoist Western Polissya, where the combination of high manure doses (13,3 t/hect in the part of crop rotation) and doses (NPK) 240-300 has ensured high yield of the potatoes, winter wheat and sugar beet and their low profitability (on the data of 1992) also is optimum (Ivanchuk V.F., 1984). At the same time, today in conditions of the sharply increased prices on fertilizers this conclusion is hardly correct.

The experiment (Kudrya S.I., 2004) allows to choose most economically favorable crop rotation with short rotation (4 fields), which are perspective for small-scale commodity production. 10-12-field crop rotation dominated on chernozem earlier is requiring to replace such crop rotation in particular. If there are leguminous crops in crop rotation, the yield quality and soil structure, water regime and organic substance contents are improved, if clean-cultivating - the named parameters are worsened.

The influence of local phosphorites of the Western Polissya on updating of soil by mobile nutrient elements P and K, improvement of potatoes starchiness and vitamin C contents in it and, above all, decrease the contents of heavy metals Zn, Cu, Pb, and Cd in the soil are ascertained (Shevchuk A.M., Gavrilyuk V.A., 2004). Local phosphorites on acid soils are considered as fertilizer and ameliorant of complex effect.

Phosphorite flour and apatites not only are capable to reduce deficiency of phosphorus in the soil - here their influence is comparable with traditional superphosphate, but also they block the radionuclides entry into the plants (Mudrak A.V., Volynchuk M.K., Mushko A.P., Petruk M.M., 2003).

In the long-term (since 1936) stationary experiment on chernozem typical lightly-clay (Gurevich S.M., Boronina I.I., Ruban A.Yu., 1978) comparative efficiency of the various forms of phosphoric fertilizers (superphosphate, phosphoric flour, ammophos, phosphorous-containing

waste), and also microbiological preparations capable to mobilize soil phosphoric compounds, which are difficult of access, was studied. The roughly similar efficiency of phosphorus in various fertilizers was ascertained. That allows to recommend cheaper forms instead of traditional superphosphate. The use of the microbiological preparations is appreciated as the perspective direction in the decision of the phosphorus problem.

In the stationary experiment (Nikonenko V.M., 2003) on chernozem typical the influence of the different dozes, forms both combinations of mineral fertilizers and different forms of organic fertilizers on the yield in 12-field crop rotation, including the basic crops cultivated in East Left-bank Forest-Steppe of Ukraine were studied. The experiment is carried out since 1990, the different information is received. The main conclusions are: on high fertile soils with the humus contents 5.4 % in the top horizon the dozes of organic and mineral fertilizers are expedient for lowering, for variants without them the total yield fall slightly. The fertilizers are necessary faster for quality maintenance of receiving production (in particular we shall note the role of potassium for oil formation in sunflower and sugar in beet). Thus it is not necessary to abuse with nitric fertilizers. The role of stubble plant remains for improvement of carbon balance and increase of microbiological soil activity is also important.

The availability in crop rotation of perennial grass provides normal, stable state of all parameters of properties of soils and productivity of cultures without application of manure (Lisovoi N.V., Filatov V.P., Revenko O.F., 2001), but only with the help NP- of fertilizing. Besides operating manure on change of the contents of humus even from 200 t/hect of manure does not show. The increase of the contents of a humus is marked only on 0,1 %. Let's point out, that similar was retrieved in soil with very high (5,6 %) initial contents of humus (Nepochatov O.P., Revenko O.F., 1998).

In experience on chernozem typical with high content of humus after long application (from 1970 till 1997) $N_{90}P_{90}K_{60}$ became to apply a minimum system ($N_{21}P_{21}K_{21}$) with additional application of nitrogenous fertilizers under a winter wheat and forage crops. The minimum system was economically expedient. The payback of fertilizing was increased up to 9,8 kg of a grain instead of 7,1 kg at a former system. The quality of a grain thus was improved (Dotsenko O.V., 2003).

In the stationary experiment (Habriel A.I., Petruniv I.I., Kostyuk M.M., Olifir Yu.M., 2004), which was carried out on light-grey podzolic and gleying soils (since 1965), long time the complete set of necessary cultivation methods was use (lime for acid neutralization, manure for improvement of physical soil properties, mineral fertilizers for replenishment of nutrient storage). After use of the mentioned complex the soil state was essentially improved, that has allowed to recommend to decrease dozes of used fertilizers in future. It will not result in deterioration of economic activities.

So, in the field of the fertilizers application the following theses referred by us to new deserve the attention:

- Through decrease of cattle head number the manure becomes the critical product. Today it is out of the question that manure will be conducive to formation of no deficit humus balance in the soil (12-14 t/hect in Polissya, 8-10 t/hect in the Forest-Steppe and 5-6 t/hect in Steppe). In experiments such attempts became popular: to achieve more effective manure use owing to localization at entering, manure application in to the arable layer basis, moderate additional compaction (raising the factor of it humification), replacement manure by organic-mineral fertilizers prepared on the basis of local sources or stubble remains.

- In application of mineral fertilizers the tendencies of reduction of dozes on highly fertile soils or where before the long time the fertilizers was applied and the increases of the nutrient

content have achieved, have began to show. The local ways of fertilizer application on the appointed depth of the arable layer are effective. To the increase of their efficiency the creation of the optimum compaction level in the same layer realized simultaneous with fertilize application is promoted. It promotes economy of mineral fertilizers.

- At the same time, the mineral fertilizers are important element of crops growing technology, of the increase of profitability, improvement of quality of many kinds of agricultural production. The attempts of use of local sources of phosphorite raw material as fertilizers pay on itself attention. Besides the last have protective effect, reducing radionuclids and heavy metals entry in plants.

3. Organic agriculture

The state of the problem in Ukraine was reported in the document 2) "Description of the context ". The results of concrete researches included in to the database, while are small.

The criteria of an estimation of soils suitability for cultivation of non-polluting production (Kysil V.I., 2000) are designed. 75 % of lands of the Kharkiv area are suitable for these purposes, 20 % - restrictedly are suitable, on 5 % such production to grow riskily. There is the same information for whole country.

In the work (Kysil V.I., Shevchenko N.G., Akimova R.V., Komova V.B., 2001) on chernozem podzolic the efficiency of fertilizers in traditional, alternative (only organic fertilizers and mechanical methods of destructions of weeds) and biological (organic fertilizers, mineral fertilizers applied by a local way in the combination with mineral fertilizers and lime and mechanical ways of destruction of weeds) systems were investigated. On the majority of parameters and especially on ecological results and production quality the biological system was the best.

In the work (Kysil V.I., Kryvoruchko A.T., Pugachov V.A., Akimova R.V., 2002) was studied comparative efficiency of organic-mineral fertilizers - OMF (prepared on the basis manure and calcium containing substances), manure, manure in the combination with straw and nitric fertilizer (on the basis of 10 kg / 1 t of straw), applied to the soil in different quantity (from 2 up to 10 t/hect). The highest humus accumulation was marked on the variant OMF+manure and straw. The burning of straw has reduced the humus contents and microflora. The exception of mineral fertilizers did not reduce high economic results (for example, the crop of sunflower was 4.21 t/hect at high profitability).

In the work (Kravchuk Yu.I., Tarnovskaya I.A., 1999) was studied the efficiency of different fertilizers systems: traditional, based on organic-mineral fertilizers, recommended for Crimea, and biological, based on application only manure and straw. Advantage in yield had the traditional system (on the average for more than 10-year's period), but in some years and especially in the saving of energy the biological system had the advantage. It was made the conclusion about expediency of development of so-called compromise system, when in traditional system the part of mineral fertilizers needs to replace organic and in particular to leave all plant remains on the field.

In experiment (Savchenko Yu.I., 2004) the positive tendency from new organic-mineral fertilizer application is determined on condition that the ways of reduction of it prices will be found. The fertilizer is capable to improve the plant nutrient mode by nitrogen and phosphorus.

So, in Ukraine the experimental field researches in the field of organic (alternative, biological) agriculture practically only begin. Only several stationary experiments are incorporated. Their preliminary analysis shows the perspectiveness of this direction.

4. Discussion and conclusions.

Participation in the KASSA project, collecting and information processing on the scheme offered by the coordinators, have allowed to find out the following:

- As in Ukraine the network W-sites for field experiments is not advanced yet, and the publications has mainly thesis kind, it was necessary, using the scheme, to develop the appropriate form for the information collecting and to send out it to the experimental stations and high schools of the agricultural type. For this purpose we have developed the list of experiments, which can be related to innovation, namely such which are the inventory object KASSA;

- Unfortunately, it was not possible to decide the problem put by completely. First of all because not all respondents have given the answer, and what have answered to us, their materials were insufficiently qualitative. Secondly, the experimental work in the country is in difficult conditions, the carrying out the experiments is not financed practically since 1991. Therefore experiments are closed, reconstructed, become simpler. At last, in third, and this most important, most of experiments incorporated in 60-80 years were planned for high chemicalization level, the traditional ways of tillage and multiple-field crop rotation. Land reform and long-term crisis in agrarian sector have changed the situation cardinally. On the foreground the practically new ecological and economic requirements were put forward. Before the scientists the practical workers have felt necessity of introduction new resort and ecological approaches. The experimental work varied slowly, new experiments were not setup almost. In these conditions it was necessary "try to find out" innovation elements in "old" experiments, and also to use not numerous experiences, which it was possible to find.

- The analysis of experiments has revealed one more negative tendency. Even in leading establishments the carrying out of the experiments, as a rule, is not accompanied by the detailed associated researches. And if it is still admissible for short-term experiments, in which it is difficult to expect changes of soil properties and modes, in long-term experiments such situation is unacceptable. For this reason the degree of completion of the forms has appeared low;

- By us is collected and processed 45 experiments in all, including on tillage 19, fertilizing 21, organic agriculture 5. The Experiments included in base are incorporated in last 30-40 years, they are submitted enough in the geographical aspect, and however they reflect the polygenetic character of soils and economic conditions insufficiently.

- Regularities of the Ukraine's soil properties transformation as the effect of the anthropogenous activity *

Dynamics of organic matter. The humus contents in the soils of Ukraine, its stocks, profile distribution, qualitative composition, degree of mobility, the regularities of formation and mineralization, influence of the natural factors on its changes, and also tilling ways, amelioration and others agronomical methods are investigated well enough. Last years the attention to the energetic soil characteristics is given.

On the different data humus contain in Ukrainian tilled chernozems is less on 20-40% in comparison with the virgin soils, and at once after plowing during 10-15 years the loss occur

* The material was prepared on the basis of experiments included in base, and also on the basis of agrochemical land certification (7 rounds everyone 5 years, since 1965), land-survey (the data were updated approximately 3 times, since 1957), and also of monographic summary editions which have been not included in base.

quickly, then the rates of losses are slowed down. Organic fertilizers application, unmouldboard tillage, grass introduction into the crop rotation, even seeding of crops, direct sowing are reduce humus mineralization. Last time in connection with shortage of manure large attention is paid to other sources enriched the soil by organic substance (sapropel, green manures, peat and organic-mineral fertilizers prepared on it basis), and also to plant remains. The importance of stopping the losses of organic substances with water erosion is emphasized.

Soil erosion. Under Land cadastre, in Ukraine about 30 % of agricultural land are eroded (by water and wind). However these data, most likely, are overestimated, because reliable methods of differentiation washed off and short-profile hillside soils are not developed. The erosion is the important problem lowering efficiency of agricultural and creating various ecological difficulties with silting both pollution of the rivers and reservoirs. In the country the geography and intensity of erosive processes, their mechanisms and factors are well enough known, there are estimations of risk, damage, forecasts, the various models (including WEPP) for the erosion description are tested, there are many base farms, where it is practically suspended. The basic methods are: agrotechnical and erosion-preventive organization of the territory. The efficiency of first is insufficient, second - are extend on the small areas. The large hopes assign to reduction of the arable land area and in this connection to optimization of cropland and increase of territory stability. However because of a number of scientific-organization questions are not solved the problem of erosion is one of sharpest in the country and such situation, probably, will be kept in nearest, and can be, and long-term future.

Besides in connection with insufficient scientific validity of drainage in north of Ukraine, in Polissya, and appearing in this connection large-scale array of overdrained soils, new erosive problem - wind erosion has appeared here. In this zone the problem of erosion is badly studied, real measures of struggle with it are absent.

The physical and microbiological erosion aspects, crust appearing are studied in the country in a narrow range.

Soil contamination. During intensive chemicalization of the agriculture (1965-1990) and active working industry it is one of the central problems. Further in connection with transition of agrarian sector to the extensive way of development the acuteness of the problem has decreased. Today attention is paid to radionuclides contamination only in the Chernobyl zone, and also to local forms of heavy metals pollution around of large industrial complexes in Donbass, Near-Dnieper and some other regions. Approximately about 8-11% of the territory one way or another is polluted; the influence of Pb, Ni, Cu, Cd, Cr and Cs¹³⁷ (in Chernobyl zone) is most obviously.

The problems of interaction of heavy metals with soil, their entering the plants, influence of different methods on the reduction of their contents in final production - are studied actively. The permissible levels of heavy metals presence in the soils, plants, and water are determined; the ideas of ecological normalization, regionalization and methodological approaches to the solution of the task of reduction of soil pollution are evolved.

Physical and physicochemical soil properties. Most typical processes accompanying modern agricultural practice of Ukraine are deaggregation (the effect of humus losses and intensive machining), overcompacting (the effect of influence of running systems of machine-tractor units), crust formation, acidification (the effect of passion for physiologically acid fertilizers in beet sowing regions), calcium loss (in separate regions). In irrigated conditions secondary alkalization and salinization (on the small areas) are dominated. For degradation processes their geography (there are the maps) and intensity of appearance is described, the causes, mechanisms are determined, the ways of elimination are substantiated.

- Dominated in Ukraine chernozems with favorable (for the most part) water-physical properties and nutritive mode create the necessary prerequisites for minimalization of physical and chemical loading without essential decrease in yield and economic factors. As the idea of optimum root layer is evolved, the agronomical specifications to new means and technologies of crops cultivation are formulated, in the near future quite real there will be the decision of the problem of soil parameters optimization for realization of plant and grade potential. However in Ukraine such is possible mainly in the Forest-Steppe zone, where are located best chernozems typical powerful of loam texture. In other zones, where the water regime is not settled, where on the significant areas are submitted washed off, gleying, salted, solonetzic, acid and others soils with overt defects, the ability of minimalization of chemical and physical loading are much less. Here, on the contrary, are necessary active reclamation works;

- The inventory of the experiments has shown the perspectiveness of introduction the following innovating directions in agricultural practice of Ukraine:

- *Restriction of the plough use, increase of the soils areas tilled by subsurface, chizel, different disk, combined tools, biphase tillage or not tilled at all;*

- *Routing movement of units on the field at performance of technological operations needs wide approbation, as it reduces the compaction of field area, and the standard of the permissible load at its use by the manufacturers, is capable to remove from the agenda the problem of soil overcompacting at all;*

- *There are obviously underestimated and not used in practice the ability of chemical and hydraulic engineering reclamation, contour-ameliorative of organization of territory, mulching, new forms of fertilizers, local fertilizing application (especially organic), home raw sources of organic and mineral fertilizers, biologization in landusing especially at the expense of wide utilization of plant remains;*

- *Ecologically clean output production.*

- Unfortunately, listed innovation elements while only arise in Ukraine. They are insufficiently scientifically substantiated and are very poorly submitted (except for surface tillage under winter wheat after the not steam predecessors) in manufacture. Besides their wide expansion is retarded because of absence of the suitable technical equipment for the minimal tillage, combined and soil cultivated machines of direct sowing, technical equipment for local fertilizers application, crushing of the plant remains.

- In the nearest years in agrarian sphere of Ukraine, in connection with land reform and introduction of a private property on the land the essential changes in organization and technology of crops cultivation are expected. The differing by form corporate enterprises based on private property on the land or the rent relations are developed. As an effect, will be diversified the technologies of crops cultivation - from intensive resources-saturated up to extensive low technological. However irrespective of the form and the technologies of managing the recommendation for economical and most of effective soil use and resources will be most claimed;

- Also it is necessary to expect the increase of the interest to ecologiprotecting technologies especially after constituting of the Land code (2001), Law on the land protection (2003) and Law on the control and rational soil use (2003). In this aspect the information, taken as a result of inventory, will be especially useful.

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