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THE MAIN COMPONENTS OF STUDIES AND RESEARCH OF CONSERVING SOILS AND WATER IN TECHNOLOGIES OF AGROENGINEERS TRAINING

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Summary. The basis of study of soils and water resources by future specialists in agroengineering in higher educational institutions is presented. Innovative pedagogical technology is developed according to the method of gradually increasing educational load, which follows from previously learned and mastered material. The acquisition of professional competencies for agroengineering will ensure the development of project activities on the basis of preservation and even multiplication of natural resources. In the training process of agroengineering development, it is important to develop the mathematical apparatus for the necessary calculations, which will ensure optimization of the parameters of technological processes and structures.
Keywords: agroengineering, technological process, soil, agricultural machines, slopes, water erosion.

1. Introduction

In higher agricultural educational institutions of Ukraine, agroengineers obtain higher education of the first (bachelor) and the second (− master's) educational-professional levels. Applicants of higher education of the first educational-professional level get a degree − a bachelor, qualification − an expert in the field of agroengineering. At the same time, the normative term of training is three years ten months, and the volume of educational-professional program − 180-240 credits ECTS. The second level of higher education is awarded to a degree − a master's degree, qualification - a master's degree in agroengineering. ECTS credits required for a higher education degree − master; on the basis of the first (bachelor) level, the educational-professional program is 90 credit ECTS, and educational-scientific program − 120 credits. At the same time, at least 35% of the volume of the educational program should be aimed at obtaining general special (professional) competencies in the specialty defined by the Standard of Higher Education. Along with the acquisition of special professional competencies, it is important that agroengineering specialists be aware of the problematic issues of soil protection energy, resource and moisture technologies of growing crops both in Ukraine and in the world as a whole.

2. Prerequisites and means for solving the problem

Due to the considerable scientific contribution of scientists, agroengineering pedagogical science and educational practice have great achievements and results. Significant contribution to the fundamental scientific results from the study of problem issues on the theory of content and technology of psychological and pedagogical training of specialists in agroengineering in their scientific works was highlighted by I. Bender, V. Manko, O. Kulchytska, I. Lerner, V. Rybalka, M. Dumchenko, N. Kuzmin, P. Luzan, V. Duganets and others.

New standards of education include significant changes in the structure, content, goals and objectives of training agroengineering specialists. With this in mind, the research of the role of project preparation in shaping the professional competences of future specialists in agroengineering, the results of which are presented in [1]. In [2], the peculiarities of using the method of projects in pedagogical theory and practice of forming professional competences of future agroengineers in higher educational institutions are highlighted. The method of projects in teaching technology involves solving the actual production agrotechnical problem or task, and with this method obtain a concrete result in the form of innovative scientific and technical documentation or other product that can be presented, publicly defended, passed on to the customer.

A number of scientific works of well-known scientists such as M. Shikul, P. Zaika, N. Dolya, O. Gnatenko, L. Petrenko, M. Kapshtika, M. Manojlovich, R. Meissner and others are devoted to the urgent problems of protection of soils and water resources. The especially important production problem is the optimization of nutrient and water regimes of the soil on the slopes. A number of scientific works are devoted to the features of soil preparation for sowing crops on sloping lands, optimization and management of technological processes in these conditions. These include [3, 4, 5]. Classical, practically oriented, as well as the most up-to-date developments and developments of scientists in the form of didactic materials are covered in textbooks, manuals, methodological textbooks, and they are used in the training process of agroengineering.

The textbook [6], which consists of the theoretical part, the methodological development of laboratory and calculation works and test tasks, presents the results of research on the man-caused pollution of soils, their detoxification and recultivation, describes the design, methodology of calculation and designing of machinery and equipment for the preparation of land for development, culturological works and irrigation of fields, regulation of water regime of soil, laying of open channels, their maintenance and cleaning, formation of anti-filter irrigated screens, the determination of the stability of the bulk part of anti-erosion structures on the slopes, the study of the influence of soil categories on the productivity and traction resistance of bulldozers, etc.

3. Results and discussion

In pedagogical technologies of agroengineering training, considerable attention is paid to the study and study of soil condition with the detailed description of their mechanical and technological properties. This is happening at each course during the entire period of training in accordance with the cross-cutting structural and logical scheme of preparation of agroengineering specialists, which is reflected in separate points of the programs of academic disciplines such as "Introduction to the specialty" and training practice in agricultural machines - 1st course of training, "Mechanic -technological properties of agricultural materials","Plant growing " − 2nd year,"Agricultural machines"− 3rd year, "Operation of Machines and Equipment"− 4rd year. The normative part of the master's educational-professional program of both research and production in the specialty "Mechanization of Agriculture" ("Processes, Machines and Equipment for Agricultural Production," "Agroengineering") includes disciplines that study "Machines and Equipment in Agricultural Land Reclamation".

In the first year of studying students are forming a key content and conceptual apparatus, which is based on the understanding that in the field of plant growing, land resources form the basis of agro-industrial activities, and the soil environment is the main means of production. In the technological processes of cultivating agricultural crops, the land is exposed to various influences on it by the working bodies, as well as the supporting and moving elements of machine-tractor aggregates. The main condition is that this effect does not destroy the structure of the soil, retain its natural fertilizing properties, and even better to enhance them. But the intensive use of land resources leads to land degradation. Thus, only for the period from 1986 to 2010 the content of humus decreased by 0,2% and amounted to 3,1% on average in Ukraine [4]. During this period, losses of humus in the arable layer amounted to 5,5 t/ha. Together with a crop of crops from one hectare of land each year 77 ... 135 kg of nutrients are exported. Unfortunately, such a negative trend - the decline of soil fertility, continues to this day. Students need to know about it, and becoming experts in the field of agro-industrial production in the future not only to prevent these negative phenomena, but also to care for the growth of the fertility of the land.

At the 2nd year of training in accordance with the program "Plant Growing" students learn how to sample and conduct agrochemical analysis of the soil: the content of humus, as well as nitrogen, phosphorus, potassium and other chemical elements, soil acidity. During the study of the discipline "Mechanical and technological properties of agricultural materials" students study and investigate the physical and technological properties of the soil as a cultivation object, the mechanical and technological properties of fertilizers as the object of mechanized introduction into the soil, the properties of the seed material, the technological properties of pesticides, which are used for plant protection, etc.

The basic physical properties of soils, which are studied and researched by students are: granulometric and structural aggregate composition, stony, volumetric mass, porosity, humidity, color of soils. Special attention in the educational process of agroengineering is given to the technological properties of soils, which are manifested in the process of their cultivation and significantly affect the technical and economic indicators of agricultural production, cost and profit. These properties include: the ability of soils to loosen and crush, hardness, friction coefficient, soil resistance to deformations (permissible vice on the ground of mobile field aggregates, shear and cut resistance, internal friction and soil cohesion, soil strength, resistivity in plowing), adhesiveness, abrasiveness, ductility, elasticity, viscosity, fragility.

On the third year of studies the future agroengineering specialists have to consolidate and extend knowledge on the mechanical-technological properties of soils (hardness, volume factor, angles and coefficients of friction in the working and auxiliary parts of machines, etc.) through the analysis of the theory, experimental research in laboratory or field conditions, processing the received data and analyzing the results. For this purpose, they use special devices and equipment: a spring hardness tester, 2 millimeters of tape or a blank paper in the size of 70 x 500 mm (two sheets of paper can be used from a notebook, joined together), a hardening of a shock action, various soil samples for the study of their properties in laboratory conditions - 2 variants, the device for the experimental determination of angles and calculation of the coefficients of external friction of the soil.

Before beginning the research, students deeply analyze the basic concepts, terms and definitions. For example, let's list some of them.

The coefficient of soil texture – serves to evaluate it after cultivation. It is calculated as

$$K = m_1/m_2, \quad (1)$$

where m_1 and m_2 – мass of aggregates in size, respectively, 0,25 ... 7 mm and the rest of the soil.

Strength – differs depending on the type of deformation. For example, for clay soils the tensile strength is 5-6 kPa, and at compression – 65-108 kPa.

The hardness of the soil P – is the ability of soil to resist entering into it under pressure from any device in the form of a cone, cylinder or ball. The hardness of the soil characterizes the total resistance which is being overcome by tillage machines, performing the environmental destruction by means of different strains. The hardness of the soil is determined by special devices – rigid meter ones. A scheme of a rigid meter for the first time is offered by acad. V.P. Goryachkin. The principle schematic diagram of the hardness is based on the principle of action dynamometer and was improved in the future, and it is widely used. Average soil hardness:

$$P = \frac{Y_i k}{S}, \quad (2)$$

where Y_i – the average ordinate of the diagram at a depth on which the hardness is determined; k – stiffness of the spring of the rigid meter; S – cross-sectional area of the deformer.

Such rigid meters which were suggested by – Goryachkin, Vysotsky, Revyakin are the devices of discrete action and measure the resistance of the soil to the vertical entrance of the device tip.

Using the diagram of a rigid meter it is possible to determine the coefficient of volumetric grinding of soil.

$$q = \frac{F}{V} = \frac{F}{(S \cdot h_x)} = \frac{P}{h_x}, \quad (3)$$

where F – compression force; V – volume of soil in the phase of consolidation.

Friction during a soil cultivation can play both positive and negative roles. The negative role of friction is manifested in the working parts of soil-working machines; friction increases traction resistance of the machine, accelerates the wear of surfaces that interact with the soil. The positive role of friction is that it increases the grip of the wheels with the ground, improves the handling of the unit and reduces the towing. External friction is described by the Amont law, according to which the frictional resistance is proportional to the force of normal pressure *N*.

According to V.P. Goryachkin, the coefficient of friction for a pair of a metal-soil where f = 0,5, with the friction angle φ = 26°30′. If it is necessary to take into account the specific mechanical properties of the soil for different zones, then for the choice of coefficient of friction you can use the data proposed by G.N. Sineokov, which are shown in the table. 1

Table 1

Numerical data of the angles and coefficients of friction of the ground on the steel

Soils	Angle of friction	Friction coefficient
Sand and sandstone: loose	14°- 19°30′	0,25-0,35
connected	25°30′-35°	0,50-0,70
Easy and medium loose	19°30′-26°30′	0,35-0,50
Heavy loams and clay	31°-42°	0,60-0,90

The smaller value of the coefficient of friction for the given soil corresponds to lower humidity, the bigger – higher humidity. Friction is often accompanied by sticking of the soil to the metal surface. External friction and adhesion – are two different phenomena of the same process – slipping of the soil on the metal. However, the laws of friction and adhesion are different.

In the special methodological textbooks on the theoretical course of agricultural machines is presented the performance of laboratory work and the content of the report. This includes the following.

1. Describe the characteristics of the soil − hardness, volume of the cracking coefficient, angles and coefficients of external and internal friction, etc., to analyze their influence on the implementation of agricultural devices of technological processes.

2. Draw a diagram of a spring-loaded hardness meter, while revealing the mechanism of spring deformation and the kinematic scheme of information transmission from the spring to the self-recording device in 3, 4 characteristic positions. By analyzing the kinematic scheme of the work of the self-recorder, establish the relationship between the deformation of the spring and the displacement of the pencil from the conditional zero line.

Determine the hardness of the soil and examine its change according to one of the factors, namely: depending on the change in the mechanical composition of the soil, depending on the location relative to the edge of the field or depending on the change in soil moisture. Experimental studies should be carried out on one of the factors chosen from the above. To do this, use one tape for each of the 2 soil variants of the selected factor. To determine the hardness of the soil on each variant make 3 ... 5 measurements. At the same time on each of the 2 tapes will be shown the above number of graphs. Determining the depth of the tip of each centimeter of the ordinate and finding their average values to construct a graph, which is an average graph of the graphs, which are obtained experimentally. From the constructed graph of meant values, determine the hardness of the soil at depth 2; 4; 7; 10; 15; 20 cm. Construct graphs of averages and determine the hardness of the soil which should be for each of the 2 variants. Hardness of the spring of the hard-meter $K = K_v + K_м$ = 0,82 kN/m + 1,33 kN/m = 2,15 kN/m.

Total points of conducting researches on determination of technological properties of soil are 8.

On the 4th year in accordance with the discipline "Operation of Machines and Equipment" students study the scientific basis of effective use of technology, expand knowledge of the general characteristics of technological processes of soil cultivation, agronomic requirements for operations, etc. So, for example, plowing is used in the absence of wind erosion, and field-free cultivation is used in conditions of insufficient moisture and in the presence of wind erosion. On sloping lands, according to agrotechnical requirements, the movement of the unit must be carried out across the slope.

Master's training involves the formation of professional knowledge and skills of efficient use of land, water and other natural resources in accordance with the needs of agricultural production based on the study of the bases of mechanized technological processes of construction and maintenance of reclamation facilities, the structure and operation of reclamation machines, the combined effect of technological, technical and organizational factors, which enables restoration and further development of modern environmental remediation systems.

For example, let's consider one of the 11 laboratory and practical works performed by undergraduates – "Determination of the stability of the bulk part of anti-erosion structures on the slopes" [6]. Purpose of the study: to research the features to master the method of determining the stability of the bulk part of anti-erosion structures on the slopes in the development of technological processes of soil protection from water and wind erosion and increase its fertility.

Initially, the master students study and investigate the stability of the bulk part of anti-erosion structures on the slopes. It is worth noting that the issue of the stability of soil terraces is associated with the definition of the greatest steepness in which it is advisable to terrain the slopes. The determination of the stability of bulk slopes was studied by prof. I.N. Tsitovich, A.M. Panchenko and other scholars. In the theoretical substantiation of the stability of the bulk part of anti-erosion structures on the slopes, one can assume that the surface of the slip is previously known and it coincides with the surface of the slope.

The equilibrium of the forces acting on the bulk of the terrace is as follows:

$$T - N\,f - C_{щ}\,l = 0, \qquad (4)$$

where T − tangential forces that arise in the plane of sliding; N − ковзання normal forces that arise in the plane of sliding; f − coefficient of internal friction of the soil; $C_{щ}$ − specific soil grafting; l − the length of the surface of the slide (Fig. 1).

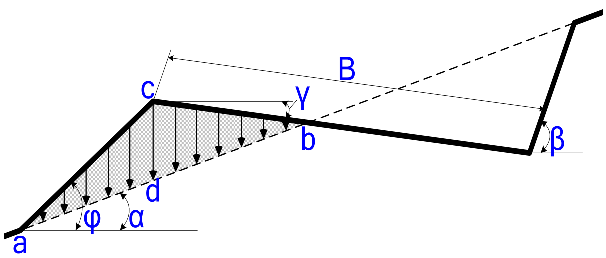

Fig. 1 Scheme for determining the stability of the bulk slope on the slope

When determining the equilibrium conditions, the shrinking array neglects the emerging lateral pressure. The greatest load in the body of the bulk part of the terrace will be under point c (Fig. 1), from where

$$cd = \frac{B\sin(\alpha+\gamma)}{\cos\alpha\left[1+\sqrt{\dfrac{\sin(\beta-\alpha)\sin(\varphi+\gamma)}{\sin(\varphi-\alpha)\sin(\beta+\gamma)}}\right]}; \qquad (5)$$

$$bd = \frac{B\cos\gamma}{\cos\alpha\left[1+\sqrt{\dfrac{\sin(\beta-\alpha)\sin(\varphi+\gamma)}{\sin(\varphi-\alpha)\sin(\beta+\gamma)}}\right]}; \qquad (6)$$

$$ab = \frac{B\sin(\varphi+\gamma)}{\sin(\varphi-\alpha)\left[1+\sqrt{\dfrac{\sin(\beta-\alpha)\sin(\varphi+\gamma)}{\sin(\varphi-\alpha)\sin(\beta+\gamma)}}\right]}. \qquad (7)$$

The equation (5 – 6) can be used to construct the shear of the distribution of the shear stress of $\tau_{зс}$ and the shear resistance $\tau_{оп}$ of the forces acting in the slip plane

$$\tau_{зс} = \frac{G\sin\alpha}{F}, \qquad (8)$$

$$\tau_{оп} = \frac{G\cos\alpha}{F} + C_{щ}F, \qquad (9)$$

where $\boldsymbol{G}$ – the mass of the moving wedge; F – area of contact of the bulk part of the terrace with the slope surface.

The mass of soil gravity depends on its consistency (Table 2).

Table 2

Mass of soil gravity depends on its consistency

Consistence the soil	Loam			Supysok		
	$\gamma_{об}$, T/m^3	$\varphi°_2$	$C_{щ}$, N/cm^2	$\gamma_{об}$, T/m3	$\varphi°_2$	$C_{щ}$, N/cm^2
Okay	2,15	25	6	2,05	28	2
Half-hard	2,10	23	4	2,00	26	1,5
Tumultuous	2,00	21	2,5	1,95	24	1
Flexible	1,90	17	1,5	1,90	20	0,5
Cecoplastic	1,85	13	1	1,65	18	0,2
Flowing	1,80	10	0,5	1,80	14	0

In the literature, the degree of stability of earthen slopes is characterized by the magnitude of the coefficient of stability k_{cm}. It is accepted that the coefficient of stability of slopes can be determined using the formulas used to calculate the stability of slopes by the method of circular cylindrical sliding surfaces, that is,

$$k_{ст} = \frac{N\,f + C_{щ}\,l}{F}. \qquad (10)$$

To determine the forces N and F it is necessary to know the weight of the shifting wedge, which for 1 m of the length of the terrace can be determined by the formula:

$$G = \frac{\gamma_{об}B^2\sin(\beta+\gamma)\sin(\alpha+\gamma)}{2\sin(\beta-\alpha)\left[1+\sqrt{\dfrac{\sin(\beta+\gamma)\sin(\varphi+\alpha)}{\sin(\varphi+\gamma)\sin(\beta-\alpha)}}\right]^2}, \qquad (11)$$

where $\gamma_{об}$ – volumetric weight of soil.

Substituting in (10) the values of N, F and l on their expressions, after transformations we obtain the formula for determining the coefficient of stability of the bulk slopes of the terraces:

$$k_{ст} = f\,\mathrm{ctg}\,\alpha + \frac{2C_{щ}\left[1+\sqrt{\dfrac{\sin(\beta+\alpha)\sin(\varphi+\gamma)}{\sin(\varphi+\alpha)\sin(\beta+\gamma)}}\right]}{\gamma_{об}B\sin\alpha\sin(\alpha+\gamma)}. \qquad (12)$$

Then the undergraduates are familiar with the order of the fulfilling of a work [6], execute it and draw up a report.

4. *Conclusion*

In the pedagogical technologies of the preparation of future agroengineers considerable attention is paid to the problem issues of soil and water conservation. During the entire period of studies, students study and research the mechanical and technological properties of soils as the main means of agricultural production continuously and consistently. In the project activity for the initial

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parameters primary consideration is given to soils with their characteristics and parameters with the obligatory preservation of their fertility in the technologies of agricultural production of the crop production sector.

5. *References*

1. Pryshliak Viktor. Role of project preparation in formation of professional competence of future specialists in agroengeneering / Viktor Pryshliak // TRANS MOTAUTO WORLD: International scientific journal. – Sofia, Bulgaria: trans & MOTAUTO WORLD, YEAR II, ISSUE 4/2017. – 162-165, ISSN PRINT 2367-8399, ISSN WEB 2534-8493.

2. Pryshliak Viktor. Method of projects in the theory learning of a future agricultural engineer / Viktor Pryshliak // TRANS MOTAUTO WORLD: International scientific journal. – Sofia, Bulgaria: trans & MOTAUTO WORLD, YEAR I, ISSUE 4/2016. – 39-41, ISSN 2367-8399.

3. Pryshliak Viktor. The peculiarities of the work of tillage machines on the sloping lands / Viktor Pryshliak // MECHANIZATION IN AGRICULTURE: International scientific journal. – Sofia, Bulgaria: Scientific technical union of mechanical engineering Bulgarian association of mechanization in agriculture, YEAR LXII, Issue 4/2016. – 6-8, ISSN web 2534-8450.

4. Bondar S.M., Pryshlyak V.M., Shymko L.S. Management of complex machines in manufacturing processes cultivation: monograph. – Nizhyn LLC "Publishing" Aspect-Polygraph ", 2015. – 524.

5. Pryshliak Viktor. Study of physical and technological processes of planting crops on slopes of priority agricultural crops in bioethanol industry / MOTROL: Motoryzacja i energetyka rolnictwa, An international journal on operation of farm and agri-food industry machinery. – Lublin–Rzesów: Mot. and Energ. Rol., Commission of Motorization and Energetic in Agriculture, 2013. – Vol. 15, No 5, 181-187.

6. Mashyny ta obladnannya v sil′s′kohospodars′kiy melioratsiyi: Pidruchnyk / H.M. Kaletnik, M.H. Chausov, M.M. Bondar, V.M. Pryshlyak ta in. – K.: Khay-Tek Pres, 2011. – 488 s.