MINISTRY OF EDUCATION AND SCIENCE OF UKRAINE
SUMY NATIONAL AGRARIAN UNIVERSITY

Department of Agriculture, Soil Science and Agrochemistry

_   **"''APPROVED''**

Head of the Department of Agriculture,
Soil Science and Agrochemistry

_____ (Kharchenko O.V.)

"_____" _____-_____2019

EDUCATIONAL - PROFESSIONAL PROGRAM
The basics of forecasting and programming of harvests
(code and academic discipline name)

Specialty 201 «Agronomy»
(code and specialty name)

Faculty: of Agrotechnology and Environmental Use

2019 – 2020 academic year

Educational - Professional Program « The basics of forecasting and programming of harvests » for aspirants in Program Subject Area 201 «Agronomy».

Higher Education Level - «Doctor of Philosophy»

The project team consists of: D. Sc., Professor Kharchenko O.V.

Educational - Professional Program is approved at the meeting of the **Departmentof Agriculture, Soil Science and Agrochemistry**

« _____ » _____ 201 9
(Minutes No.)

Head of the Department of Agriculture,
Soil Science and Agrochemistry   _____(Kharchenko O.V.)
                                                              signature)   (surname and initials)

Approved:

Dean of the faculty of Agrotechnology
and Environmental Use   _____ I. M. Kovalenko
                                                                    (where the discipline is taught)
Dean of the faculty of Agrotechnology
and Environmental Use   _____ I. M. Kovalenko
                                                              (to which the department belongs)
Methodist of educational department   _____ G. O. Baboshyna

Registered in electronic database: date: _____ 2019

1. Description of the course

Indicators	Area of knowledge, direction of preparation, educational degree	Characteristics of the discipline
		full-time study
Number of credits – 4	**Knowledge area**: **20 Natural Sciences and food**	**Selective**
Modules - 2	Specialty: 201 **«Agronomy»**	**Year of preparation:**
Content modules –2		2019-2020
		Course
		2
		Semester
Total hours - **104**		4
Weekly hours for full-time study: classroom - 6 individual student work - 1	**Educational degree: Doctor of Philosophy**	**Lectures**
		44
		Practical classes, seminars
		44
		Individual work -
		16
		Type of control:
		credit

The ratio of the number of hours of class work to individual task and individual work is:
for full-time study - 86/14

2. The purpose and tasks of the discipline

Purpose: To teach postgraduate students to realize theoretically the maximum accumulation of solar energy, how to use soil and climatic resources, genetic potential of rayon varieties, material and labor resources, to obtain economically feasible crop levels and guaranteed gross crop production on an industrial basis.

Tasks: To form the theoretical and practical knowledge of the postgraduate students in:

• solving the problem of obtaining high stable yields of agricultural crops by determining the impact of major environmental factors on crop productivity;

• determination of the degree of provision of these factors in particular natural and climatic conditions and the possibility and necessity of their regulation;

• ability to evaluate the influence of limiting factors on the formation of agricultural crops and overcome their negative effects;

• ability to create agrometeorological forecasting of separate crops at different stages of their development.

As a result of studying the discipline, an aspirant has to:

know:

- Theoretical, biological, economic, organizational and technical bases of forecasting and programming of agricultural productivity of agricultural crops;

- methods of forecasting and programming;

- influence of abiotic factors and crop formation crops depending on the region of cultivation and methods of their regulation;

- the influence of technological processes on the formation of yields and the search for relationships between abiotic factors and technological processes;

- basic methodological approaches to the use of computer technology in the process of yield programming and creating the necessary conditions.

be able:

- to establish the conditions that are most often in a specific natural and climatic zone, to determine the projected (resource) yield of basic crops;
- ensure that all technological operations for cultivation of the given crops are performed at the high level recommended by science and proven by practice;
- to determine economically feasible rates of fertilizers with expert evaluation of their application depending on the price / cost ratio;

- conduct ecological evaluation of cultivation technology in terms of preserving or increasing soil fertility;
- make calculations for computer programs and formulate conclusions and suggestions.

The general competencies that the aspirant must have

Code	General competencies
ZK1	Ability to learn, master modern knowledge, self-improve and form a systematic scientific outlook
ZK 2	Ability to critical analyzing and evaluating of modern scientific achievements, synthesis of knowledge, complex problem solving
ZK 3	Ability to abstract creative thinking, identification, receiving, systematizing, synthesize and analyze of information from various sources using modern information technologies in scientific activity.
ZK 5	Ability to generate new ideas and make informed decisions to achieve goals.
ZK 8	Ability to take initiative, take responsibility, motivate people and move toward a common goal.
ZK 11	The ability to prepare scientific texts, to present, discuss, debate scientific results in their scientific work in national and foreign languages, to an extent sufficient for full understanding, demonstrating a culture of scientific oral and written language.

Expected learning results of the discipline

Code	Program Results
PRN 1	Possess advanced modern conceptual and methodological knowledge when performing research and / or professional activities and at the border of subject areas of knowledge
PRN 10	To conduct professional interpretation of received materials on the basis of modern software using existing theoretical models, to create own object-theories
PRN 13	To present professionally the results of research at national and international scientific conferences, seminars, use foreign language in scientific, educational and innovative activities
PRN 16	Organize research in accordance with the requirements of safety and health.
PRN 18	Be responsible for the novelty of research and expert decision making, motivating employees and moving toward a common goal.
PRN 20	To formulate a scientific problem with regard to the values of modern society and the state of its scientific development, working hypotheses of the problem under study, which should extend and deepen the state of scientific research in the field of Agronomy

PRN 21	To present research results in the form of a dissertation, to defend the results of a dissertation research

1. Corelation the results of the discipline with the program results

2.

Competencies	PRN 1	PRN 10	PRN 13	PRN 16	PRN 18	PRN 20	PRN 21
SK 3	*	*	*	*			
SK 4		*	*	*	*		
SK 5	*		*		*		*
SK 7		*	*		*	*	
SK 8	*		*	*	*	*	
SK 11	*		*		*	*	*

3.

SK 3. Ability to have information on the current state and tendencies of development of world and national agrotechnologies of crops cultivation.

SK 4. Ability to formalize professional applied problems in the field of agro-industrial testing, to algorithmize them.

SK 5. The ability to establish the natural prerequisites for the application of specific modifications and methods of research, the choice of rational methods of field and laboratory work and the assessment of the required accuracy of measurements and quality of the final constructions, which must be confirmed by the example of own research.

SK 7. Ability to analyze, systematize and summarize the results of experiments and research; to draw conclusions from the obtained research, to apply them in the scientific and practical sphere.

SK 8. Ability to process the obtained experimental data, to establish analytical and statistical relationships between them and the studied parameters based on the use of standard mathematical packages of information processing.

SK 11. Ability to participate in critical dialogue, scientific discussions at the international level, to defend their own position, to entrepreneurship and to take initiative in implementing the results of the dissertation research.

3. The program of the discipline
Module 1. Resource justification of crop yield level

Topic 1. Introduction. Scientific and biological basics of crop programming. crop prediction and programming as a science. Object, Methods of Crop Programming. Definition of crop programming as biological science of management of the process of formation of a given yield. The concept of crop planning, forecasting and programming. The essence, principles and stages of crop programming. The purpose and objectives of crop prediction and programming - as a discipline, its integrality and its interconnection with other disciplines.

Topic 2. Climatic conditions and resources of weather factors in different zones of Ukraine. Agrometeorological forecasts, their main groups. Natural resources of different climatic zones of Ukraine. Light and heat as cosmic factors of plant life and energy flows of agroecosystems. Quantitative and qualitative assessment of these flows, their specificity. Quantitative models describing the integrated use of heat and reserves of productive water in the process of creating plant products. Water and carbon dioxide as terrestrial natural factors of plant life and economic resources that determine the formation of yields. Determination of the real potential yield on the resources of productive moisture, as an example of a quantitative model that characterizes the use of agroecosystem material flow. Information-logical reflections of soil fertility and mineral nutrition conditions of plants. Quantitative models of soil fertility reproduction. Determination and selection of soil fertility criteria. Types of fertility and ways of reproduction of soil fertility. Indicators characterizing agronomically valuable soil properties. Yields on the basic resources of natural soil fertility. Requirements of basic crops for hydrothermal conditions of the growing season. Establishment of the most probable weather conditions.

Topic 3. Resource yield levels and assessment of the most likely conditions. Agrochemical basics of crop programming. Quantitative models of reproduction, optimization and management of soil fertility. Methods for developing quantitative models. Complex methods of soil, leaf, plant diagnostics as the main components of programs of optimization of mineral nutrition of plants. The formation of the assimilating surface and its relationship with the absorption capacity of the root system and soil fertility. Optimal area of assimilating surface (AS) of sowing and photosynthetic potential (FP). Determination of the productivity of AS of biological yield, based on the weighted average pure photosynthesis productivity (PFP), as an example of the development and use of a quantitative model. Features of prediction of yield of basic crops. Forecast of nitrogen fertilizer application. Agrometeorological forecasting of yield under irrigation conditions. Forecasting the yield of spring barley. Winter wheat yield forecasting. Features of forecasting the yield of potatoes and corn.

Topic 4. The level of intensity of a variety or hybrid of crops and the intensity of use of moisture resources and basic elements of mineral nutrition. Technological map of crop cultivation as a system of models for prompt determination of qualitative and quantitative values of methods and means of care of crops. The role of crop genotype. Use in quantitative models of programming

and forecasting of crops, numerical indicators characterizing the type and genotype of the crop (intensity, elements of the structure of the crop, their economic value, requirements to the conditions of life, removal and use of nutrients, formation of the assimilating surface and photosynthetic potential). Preparation of prognostic and control models of programmed yield formation. The main indicators of these models.

Topic 5. Principles of establishing the project yield of a particular variety or hybrid with determining the required rate of fertilizers. Setting the programmed crop level. Technological costs for growing crops. Estimated profit. Establishing an economically optimal level of complete mineral nutrition. General method of determination. Establishment of the optimum rate of mineral fertilizers for crops, with the condition of evaluating their effectiveness. Setting the required price level for mineral fertilizers if profit is required.

Module 2. Ecological and economic substantiation of crop yield level.

Topic 6. Comprehensive impact of limiting factors and efficiency of use of basic resources.

The limiting factor and its consideration. Determination of the necessary correlation between price indices to ensure the economic feasibility of using mineral fertilizers. Setting the required price level for mineral fertilizers, provided that the required level of profitability of cultivation of the crop is provided. Setting a critical price for fertilizers, taking into account the cost of production.

Topic 7. Features of crop programming on the reclaimed lands. Establishment of economically feasible level of nutrition of crops with the adopted cultivation technology. Assessment of the level of favorable conditions and establishment of the main indicators of economic efficiency of the application of fertilizers for crops under specific meteorological conditions. Conditions for increasing profitability from the use of fertilizers on reclaimed land. Practical examples of definitions. General characteristics of reclaimed land. Features of using reclaimed land in agriculture. Assessment of the expediency of using reclaimed land.

Topic 8. Ecological bases of cultivation of crops, balance of humus and basic elements of mineral nutrition and conditions of its deficiency. Method for determining humus balance. Environmental substantiation of mineral fertilizer norms in terms of ensuring a deficit-free balance of basic nutrients. Determination of the balance of the basic nutrients in the soil, while minimizing the rate of fertilizers. Determination of the balance of the basic nutrients in the soil provided the formation of the project yield. Environmental assessment of fertilizer rates by actual crop yield. Mineralization of humus and its quantitative assessment by different methodological approaches (Chesnyak G.Y., Likov A.M., depending on "Derzhrodyuchosti"). Characteristics of conditions for formation of deficient humus balance.

Topic 9. Fundamentals of energy and economic evaluation of crop production. Identifying the strengths and weaknesses of growing crops in Ukraine. Economic analysis and energy evaluation of crop production in Ukraine.

Topic 10. Information technologies in agriculture in crop programming and ways of their realization. Information flows. Information base, its features on the basis of computer technologies of productivity programming. Economic-mathematical approaches and decision-making criteria. Application of correlation-regression analysis in agriculture. Information technologies in agriculture in crop programming and ways of their realization.

4. 3. The structure of the discipline

Content of modules and topics	Number of hours					
	Full-time study					
	total	including				
		Lec.	Pr.cl.	Lab.	Ind. w	Ind.t.
1	**2**	**3**	**4**	**5**	**6**	**7**
Module 1. Resource justification of crop yield level						
Content module 1. Resource justification of crop yield level						
Topic 1. Introduction. Scientific and biological basics of crop programming.	8	4	2			2
Topic 2. Climatic conditions and resources of weather factors in different zones of Ukraine.	14	6	2			6
Topic 3. Resource yield levels and assessment of the most likely conditions. Agrochemical basics of crop programming.	14	6	6			2
Topic 4. The level of intensity of a crop variety or hybrid and the intensity of use of moisture resources and basic elements of mineral nutrition.	12	4	6			2
Topic 5. Principles of establishing the project yield of a particular variety or hybrid with determining the required rate of fertilizers.	10	4	6			
Together for Content Module 1	58	24	22			12
Total	58	24	22			12
Module 2. Ecological and economic substantiation of the crop yield level.						
Content module 2. Ecological and economic substantiation of crops.						
Topic 6. Comprehensive impact of limiting factors and efficiency of use of basic resources.	8	4	4			
Topic 7. Features of programming of crops on the reclaimed lands.	8	4	4			
Topic 8. Ecological bases of cultivation of crops, balance of humus and basic elements of mineral nutrition and conditions of its deficiency.	8	4	4			
Topic 9. Fundamentals of energy and economic evaluation of crop production.	10	4	6			
Topic 10. Information technologies in agriculture in crop programming and ways of their realization.	12	4	4			4
Together for content module 2	46	20	22			4
Total	104	44	44			16
Ind. task						
Total	104	44	44			16

5. Topics and plan of lectures

№	Topic and plan	hours
1	**Topic 1. Introduction. Scientific and biological basics of crop programming.** Plan: 1. Crop forecasting and programming as a science. 2. The subject, objects and methods of crop programming.	**2**
2	**Topic 1. Introduction. Scientific basics of crop programming. Biological basics of crop programming.** Plan: 1. Defining the programming of crops as a biological science of managing the process of formation of a given yield. 2. The concept of crop planning, forecasting and programming. 3. The essence, principles and stages of crop programming.	**2**
3	**Topic 2. Climatic conditions and resources of weather factors in different zones of Ukraine.** Plan: 1. Agrometeorological forecasts, their main groups. 2. Natural resources of different climatic zones of Ukraine. 3. Light and heat as cosmic factors of plant life and energy flows of agroecosystems. 4. Quantitative and qualitative assessment of these flows, their specificity.	**2**
4	**Topic 2. Climatic conditions and resources of weather factors in different zones of Ukraine.** Plan: 1. Quantitative models describing the integrated use of heat and reserves of productive water in the process of creating plant products. 2. Water and carbon dioxide as terrestrial natural factors of plant life and economic resources that determine the formation of yields. 3. Determination of the really possible yield on the resources of productive moisture, as an example of a quantitative model that characterizes the use of agroecosystem material flow.	**2**
5	**Topic 2. Climatic conditions and resources of weather factors in different zones of Ukraine.** Plan: 1. Types of fertility and ways of reproduction of soil fertility. Indicators characterizing agronomically valuable soil properties. 2. Yields on the basic resources of natural soil fertility. 3. Requirements of basic crops to hydrothermal conditions of the growing season. 4. Establishing the most probable weather conditions.	**2**

6	**Topic 3. Resource yield levels and assessment of the most likely conditions. Agrochemical basics of crop programming.** Plan: 1. Quantitative models of reproduction, optimization and management of soil fertility. 2. Methods for developing quantitative models. 3. Complex methods of soil, leaf, plant diagnostics as the main components of programs of optimization of mineral nutrition of plants, correcting.	**2**
7	**Topic 3. Resource yield levels and assessment of the most likely conditions. Agrochemical basics of crop programming.** Plan: 1. The formation of the assimilating surface and its relationship with the absorption capacity of the root system and soil fertility. 2. Optimal area of assimilating surface (AS) of sowing and photosynthetic potential (PP). 3. Determination of the productivity of AS of biological yield, based on the weighted average net photosynthesis productivity (NFF), as an example of the development and use of a quantitative model.	**2**
8	**Topic 3. Resource yield levels and assessment of the most likely conditions. Agrochemical basics of crop programming.** Plan: 1. Features of forecasting the yield of basic crops. 2. Forecast of application of nitrogen fertilizers. 3. Agrometeorological forecasting of yield under irrigation conditions. 4. Forecasting the yield of spring barley. 5. Winter wheat yield forecasting..	**2**
9, 10	**Topic 4. The level of intensity of a variety or hybrid of culture and the intensity of use of moisture resources and basic elements of mineral nutrition.** Plan: 1. Technological map of crop cultivation as a system of models for prompt determination of qualitative and quantitative values of techniques and means of crop care. 2. The role of crop genotype. 3. Use in quantitative models of programming and forecasting crops, numerical indicators characterizing the type and genotype of the crop (intensity, elements of the structure of the crop, their economic value, requirements for the conditions of life, the removal and use of nutrients, the formation of the assimilating surface and photosynthetic intensities .). 4. Drawing up prognostic and control models of programmed yield formation.	**4**

11, 12	**Topic 5. Principles of establishing the project yield of a particular variety or hybrid with determining the required rate of fertilizers.** Plan: 1. Setting the programmed crop level. 2. Technological costs for growing crops. 3. Estimated profit. 4. Setting the economically optimal level of complete mineral nutrition. General method of determination. 5. Setting the optimum rate of mineral fertilizers for crops with the condition of evaluating their effectiveness. 6. Setting the required level of prices for mineral fertilizers if profit is required.	**4**
13, 14	**Topic 6. Comprehensive impact of limiting factors and efficiency of use of basic resources**. Plan: 1. The limiting factor and its consideration. 2. Determination of the necessary ratio between price indicators to ensure the economic feasibility of using mineral fertilizers. 3. Setting the required level of prices for mineral fertilizers, provided that the required level of profitability of cultivation of the crop. 4. Setting the critical price for fertilizers taking into account the cost of production.	**4**
15.	**Topic 7. Features of programming of crops on the reclaimed lands.** Plan: 1. Setting the economically feasible level of nutrition of crops with the adopted growing technology. 2. Assessment of the level of favorable conditions and setting the main indicators of economic efficiency of the application of fertilizers for crops under specific meteorological conditions.	**2**
16.	**Topic 7. Features of programming of crops on the reclaimed lands.** Plan: 1. Conditions for increasing profitability from the use of fertilizers on reclaimed land. 2. Practical examples of definitions. 3. General characteristics of reclaimed land. 4. Features of using the reclaimed land in agriculture.	**2**

17	**Topic 8. Ecological bases of cultivation of crops, balance of humus and basic elements of mineral nutrition and conditions of its deficiency.** Plan: 1. Method of determining humus balance. 2. Ecological substantiation of mineral fertilizer norms in terms of ensuring a deficit-free balance of basic nutrients. 3. Determination of the balance of basic nutrients in the soil, while minimizing the rate of fertilizers.	**2**
18	**Topic 8. Ecological bases of cultivation of crops, balance of humus and basic elements of mineral nutrition and conditions of its deficiency.** Plan: 1. Determination of the balance of basic nutrients in the soil provided the formation of the project yield. 2. Ecological assessment of fertilizer rates by actual crop yield. 3. Mineralization of humus and its quantitative assessment by different methodological approaches (Chesnyak G.Y., Likov A.M., depending on "Derzhrodyuchosti"). 4. Characteristics of conditions for formation of deficient humus balance.	**2**
19, 20	**Topic 9. Fundamentals of energy and economic evaluation of crop production.** Plan: 1. Identification of strengths and weaknesses of growing crops in Ukraine. 2. Economic analysis and energy assessment of crop production in Ukraine.	**4**
21, 22	**Topic 10. Information technologies in agriculture in crop programming and ways of their realization.** Plan: 1. Assessment and forecasting of agro-systems. 2. Information flows. Information base, its features on the basis of computer technologies of productivity programming. 3. Economic-mathematical approaches and decision-making criteria. 4. Application of correlation-regression analysis in agriculture.	**4**

6. Topics for practical classes
(full-time study

№	Topic	Hours
1	Stages and principles of crop programming	2

2	Establishment of a resource level of crop yields.	2
3	Methods for determining the potential yield	2
4	Estimation of the most probable conditions of natural moistening and provided with moisture of the crop.	2
5,6	Setting the intensity level of the variety using the resources of moisture and mineral nutrition	4
7,8	Calculation of fertilizer rates for planned level of yield taking into account the conditions of natural moisture and the intensity of the variety.	4
9	Assessment of resource efficiency of key factors.	2
10	Features of crop programming on irrigated lands	2
11	Models of response of productivity on moisture resource, design productivity	2
12	Features of programming of crops on the drained lands.	2
13,14	Methods of setting fertilizer rates.	4
15	The choice of economically optimal rate of fertilizers taking into account the intensity of the variety and the price of fertilizers and products.	2
16	Humus balance and conditions of its deficiency	2
17	The balance of basic nutrients and conditions of its deficiency	2
18	Energy evaluation of crop cultivation.	2
19	Elements of economic evaluation of crop growing.	2
20,21	Assessment of the influence of weather conditions on crop yield and the main aspects of agrometeorological forecasting of this value.	4
22	Winter wheat yield forecast.	2
	Total	44

7. Individual work
(full-time study)

№	topics	Hours
1	The purpose and objectives of crop programming - as a discipline, its integrality and its interconnection with other disciplines.	2
2	Information-logical reflections of soil fertility and mineral nutrition conditions of plants. Quantitative models of soil fertility reproduction. Determination and selection of soil fertility criteria.	6
3	Features of forecasting the yield of potatoes and corn.	2
4	Basic indicators of prognostic and controlling models of programmed yield formation	2
5	Information technologies in agriculture in crop programming and ways of their realization.	4
	Total	16

9. Teaching methods
1. Teaching methods for the source of knowledge:
1.1. Verbal: story, explanation, instruction, work with a book
1.2. Visual: demonstration, illustration
1.3. Practical: practical work, practice, industrial and practical methods.
In case of small groups the following teaching methods are used:
Personalized Learning
Differentiated Instruction
Inquiry-based Learning
2. Teaching methods by the nature of logic of cognition.
2.1. Analytical.
2.2. Methods of synthesis.
2.3. Inductive method
2.4. Deductive method
3. Teaching methods by the nature and level of students' individual mental activity.
3.1. Problematic
3.2. Partial search
3.3. Reproductive
3.4. Explanatory and demonstrative
4. Active teaching methods - use of technical means of teaching, classes at the enterprise, group researches, self-assessment of knowledge, use of educational and control tests, use of basic lectures and others).

5. Interactive learning technologies - use of multimedia technologies, interactive whiteboard, dialog learning, student collaboration and others).

9. Methods of control

1. Rating control over 100-point knowledge assessment scale *ECTS* (European Credit Transfer and Accumulation System).

2. Intermediate control during the semester (intermediate attestation).

3. Multicriteria rating of potential students' work:
•level of knowledge at practical classes, laboratory and seminar work;
• students' activity during the lesson
• the results of laboratory works;
• Express — control during the work at the lesson;
• individual work with the topic or with separate issues;
• fulfillment of analytical and calculation tasks;
• writing tasks during tests;

Assessment of the aspirant is carried out by commission (the commission includes members of the department)

4. 4. Taking into account in the final assessment of the student's fulfillment of a specific individual task:

10. Knowledge assessment scale: national and *ECTS*

Sum of points for all kinds of educational activity	rating ECTS	Rating on a national scale
		For credit
90 – 100	A	credit
82-89	B	
75-81	C	
69-74	D	
60-68	E	
35-59	FX	not credited with the possibility of re-credit
1-34	F	not credited with the compulsory re-study of the discipline

11. Methodological support

1. Assessment of methodological approaches to the ecological justification of the use of fertilizers for crops / ed. by D.Sc. O.V. Kharchenko, Candidate of Agricultural Sciences. V.I. Prasol. - Sumy: University Book, 2011. - 48 p.

2. Kharchenko O.V., Petrenko Y. M. Forecasting and programming of crops. Methodical instructions for performing laboratory and practical work on the topic "Assessment of weather conditions of the growing season" for students of the 5th year of specialty 8.130102 "Agronomy" full-time study and distance study // Sumy: SNAU, 2010. - 43 p.

12. Recommended literature
Basic

1. Kharchenko O.V. Agroeconomic and environmental basics of crop yield forecasting and programming: textbook. Manual / O.V. Kharchenko, V.I. Prasol, S.M. Kravchenko, V.A. Mokrienko;. ed.by D.Sc. Professor O.V. Kharchenko. Sumy: University Book, 2014. - 240 p.

2. Kharchenko O.V. Fundamentals of Crops Programming. - Sumy: University Book, 2003. - 291 p.

3. Lazar P.N., Mikheyev E.K. Tools and technologies of information organization in agriculture. - Kherson: 2006. – 368 p.

4. Kalinchik M.V. Economic substantiation of the rates of application of mineral fertilizers depending on the price for resources and products / M.V. Kalinchik, M.M. Ilchuk, M.B. Kalinchik. - K.: Nichlava, 2006. - 42 p.

Auxiliary

1. Evaluation of methodological approaches to ecological justification of the use of fertilizers for crops / ed. O.V.Kharchenko, V.I.Prasol. - Sumy: University Book, 2011. - 48 p.

2. Kharchenko O.V. Agroeconomic and ecological substantiation of the level of nutrition of crops / O.V. Kharchenko, V.I. Prasol, O.V. Ilchenko. Sumy:: University Book, 2009. - 126p.

3. To the problem of analytical evaluation of the effectiveness of mineral fertilizers and environmental restrictions of their norm / ed. By O.V. Kharchenko, M.G. Sobko. - Sumy: University Book, 2016. - 31 p.

4. Kalinchik M.V. Economic justification of mineral fertilizer rates depending on the price of resources and products. / M.V. Kalinchik, M.M. Ilchuk, M.B. Kalinchik. K .: Nichlava, 2006. - 42 p.

5. Guidelines for soil protection. / V.O. Grekov, LV Datsko, V.A. Zhilkin, M.I. Maistrenko,- K .: 2011, — 108 p.

6. Mikheev E.K. Information systems in agriculture (monograph), III volumes. - Kherson. - 2005. - 279 and 355p.

7. Agroeconomic and environmental assessment of crop rotations / ed. by O.V. Kharchenko, Y.G. Mishchenko. - Sumy: University Book, 2015. - 69 p.

8. Kharchenko O.V. Resource levels of crop yields and their ecological evaluation / O.V. Kharchenko, Y. M. Petrenko; ed.by D.Sc. Professor O.V. Kharchenko. - Sumy: «Mriya», 2017. - 53 p.

13. Information resources

1. http://zakon4.rada.gov.ua/laws/show/962-15
2. http://www.twirpx.com/files/husbandry/agrochemestry/