SAGRIS Module 2 description

Code	**Title of the module**
Module 2	Crop and livestock systems under climate change

1. Learning Objectives of the Module

Qualification objectives

Module objective is training higher qualification specialists (full professors/graduate students) competent to conduct advanced research resulting in ensuring sustainable food security and agriculture under conditions of the climate change.

Competencies:

PhD students are able to conduct comprehensive research, including transdisciplinary research and apply state-of-the-art quantitative and qualitative climate change research methods to ensure sustainability in agriculture.

PhD students are able to develop and implement techniques and models for sustainable development of crop and livestock systems to ensure food security under climate change conditions.

Skills:

PhD students are able to adapt research-based sustainable crop and livestock production systems to the adverse effects of climate change;

PhD are able to consider and evaluate science-based sustainable livestock production and animal welfare systems under climate change in order to maintain the safety of livestock production with minimal economic risks.

Knowledge:

PhD students acquire knowledge of best practices for the impact of climate change impacts on food security: the economic risks associated with agriculture under climate change;

PhD students acquire professional knowledge in forecasting and determining the impact of climate change on production activities, productivity and sustainability of crop and livestock systems.

Summary of the Content

Which professional, methodological, practical and interdisciplinary contents will be delivered?

The professional content of the module covers acquisition of agricultural skills for food security and sustainable development in the context of climate change.

The practical content of the module focuses on developing the ability to identify and skillfully address the practical and professional problems of crop and animal production systems under climate change conditions.

The interdisciplinary content of the module covers the process of mutual cooperation of academic disciplines in conditions of unified, continuous and holistic development in professional activity.

Teaching/Learning methods (annotation)

Will be described in content related section

Lectures-presentations, seminar-presentations, seminar with the analysis of case studies, excursion, master class

2. Preconditions for participation

Knowledge, skills, competences	Which knowledge, skills, competences are required for successful participation? knowledge and the skills acquired in a master degree program on ecology and protection of environment; agriculture and plant growing; livestock breeding; production and sale of environmentally friendly products of plant growing and animal husbandry on the basis of current normative documents are needed for successful studying of the module
Preparation for the module	Preliminary literature study, acquiring basic knowledge regarding electronic databases and resources.

3. Module references to sustainable development

Which aspects of sustainable development (economic, ecological, and social) will be treated?

Climate change radically affects the conditions in which agricultural activities are carried out and is associated with sustainable development;

In all regions of the world, plants, animals and ecosystems have adapted to the prevailing climatic conditions;

Changes in these conditions will affect them differently;

The impacts of climate change can range from reduced yields and increased variability to crop substitution and loss of agricultural biodiversity and ecosystem services;

In many regions, agricultural production is already experiencing this negative impact.

4. Exam performances (preconditions for allocation of credit points)

Type and duration (min)/	**Share in %**
A pass for a course with assessment (RU) (60 min.), answers to questions/answers / case studies project presented Exam (RK) (60 min.), answers to questions/case studies project presented	60% (current assessment) : 40% (exam)
To be determined by the university	To be determined by the university

5. Organization

Responsible for the module Olga Altaeva - 2, 4 subtopics Indira Aitzhanova – subtopics 1,3,5;		
Module type Compulsory	**Regular cycle/ Each semester or annually** Once for each enrolled PhD students according to a curriculum	**Duration** 1 term (RU) and 1st tremester (RK)
Admission equirements According to preconditions for for the module study	**Workload** 4 ZET = ECTS, ECTS = 30 hrs (RU, PK)	**Presence on semester week hours/ (including academic) hrs a week**
Workload 4 ZET= ECTS x 30 hrs = 120 hrs – General workload to be further dictriburted (RU, PK)		
Presence/Contact (lectures, laboratory works, practical studies) 60 hrs./ 50%	**Individual work** (Task or group work, self-study) 60 hrs. / 50%	

6. Module design

Subtopics	
Subtopic 1	Climate change impact on agricultural production systems
Subtopic 2	Climate change effects on food security
Subtopic 3	Sustainable resources management (water, ecosystems, land management)
Subtopic 4	Environmentally friendly crop production (healthy agricultural products)
Subtopic 5	Sustainable livestock systems and animal welfare

6.1. Subtopic description

Code	**Subtopic title:**
Subtopic 1	Climate change impact on agricultural production systems

6.2. Subtopic design

Learning outcomes

What knowledge and skills should be acquired to achieve the learning objectives of the module?
To which competences will these contribute?

Competence 1 (C1): PhD students are able to conduct complex research including transdisciplinry and use modern rsearch methods of qualtitative and qualitative aspects of climate change with a view of promoting ahricultural sustainability.
Knowledge 1 (C1K1): PhD students know current state of the current problems of climate change impact on agricultural production systems;
Knowledge 2 (C1 K 2): PhD students know transdisciplinary research on the impact of climate change on agricultural systems
Skills (C1S1): PhD students are able to objectively analyze modern scientific advances in research and apply sustainability elements in research;
Skills 2 (C1S2): PhD students are able to solve research and practical problems, including in transdisciplinary areas and support the sustainability of agricultural production systems.

Competence 2 (C2): PhD student are able to develop and implement techniques and models for sustainable development of crop and livestock production systems to ensure food security in the face of climate change.
Knowledge 1 (C2K1): PhD students know innovative methods and models for sustainable development of crop and livestock production systems;
Knowledge 2 (C2K2): PhD students know priority strategies and tactical solutions of scientific research and practical tasks in the agricultural production system under conditions of climate change.
Skills 1 (C2S1): PhD students are able to critically assess climate change impact on agricultural production;
Skills 2 (C2S2): PhD students are able to implement research results to ensure food security in the face of climate change.

Content

What professional, methodological, practical and interdisciplinary content is covered by the sub-topic

Professional content: training in agricultural skills for ensuring food security and its sustainable development in the context of climate change, involving the student in the research process.
Methodological content covers: knowledge of research methods and methodologies; understanding of algorithms for interaction and functioning of crop and livestock systems in the context of climate change; analysis of agricultural production based on an integrated system approach, modern research methods and requirements for working with scientific literature.
The practical content consists in: the ability to identify and professionally solve practical and professional problems of crop and livestock systems in the context of climate change; the ability to apply methods and tools to study the system of ensuring food security and sustainable development in the context of climate change; the ability to collect, analyze and interpret data in the field of food safety, production of environmentally safe crop and livestock products, resource management and sustainable crop and livestock systems; the ability to test the results and implement them in model forecast scenarios.
The interdisciplinary content covers: the fragmentation of research (a combination of the scientific field, production, business participants and government departments); the principle of synergy in the study (the study of related and highly specialized components of research); the integration of different sciences in one module (biology, agriculture, economics, sociology); design and implement comprehensive research, including interdisciplinary, based on a holistic systematic scientific worldview using knowledge in various fields of science.

Content:
1. Lecture-discussion: "Global climate change and its impact on crop and livestock production systems"
2. Round table: "Ways of adaptation of crop and livestock production systems in conditions of climate change"
3. Independent work review of innovative technologies in the world: "Development of new technologies in crop and livestock production taking into account climate change in the world"
4. Problem lecture: "Research of climate change impact on crop and livestock production systems (review of recent scientific achievements)"
5. Seminar - conference: "Ecological consequences of modern methods when used in the agricultural system" - 2 hours. (Aliya Nagiyeva, Dinara Seidazimova)
6. Self-study - presentation: "Strategies and tactical solutions of scientific research and practical tasks in the system of crop and livestock production under conditions of climate change"
7. Lecture-visualisation: "Peculiarities and prospects of application of fertiliser systems in innovative resource-saving crop cultivation technologies under climate change aridisation"
8. Practical-oriented lesson: "Study of a model for sustainable development of crop and livestock production systems"

9. Independent work - development of scientific article "Implementation of research results to ensure food security in the context of climate change"

Teachng/learning forms
- lecture discussion
- problem lecture,
- lecture-visualization,
- round table
- seminar conference,
- practice-oriented lesson,
- self-study

Methods of teaching/learning
Lecture-discussion, Problem lecture-discussion, lecture-visualization, Round table, seminar-conference, Practice-oriented lesson

Literature/learning materials
Literature sources:

1. Budiko M.I. Climate in the past and future. L.: Hydrometeoizdat, 1980. 351 p.
2. Contribution of the long-term stationary "Theoretical and Technological Basics of Biogeochemical Flows of Substances in Agrolandscape" in Fundamental and Applied Development of Agrochemistry (Long Experience of the RAS Geoset) / V.V. Ageev, A.N. Esaulko, V.G. Sychev, M.S. Sigida, S.A. Korostylev // Agrochemical bulletin. – 2018. – № 4. - pp. 14-20.
3. Programming of crop yields: a training manual / E. A. Ustimenko, A. N. Esaulko, E. V. Golosnoy, S. A. Korostylev, V. V. Ageev, M. S. Sigida, N. V. Gromova, A. Yu. Ozheredova, O. Yu. Lobankova, Yu. I. Grechishkina, A. A. Belovolova, A. Voskoboynikov, A. I. Podkolzin, V. G. Sychev, A. A. Kutsenko, A. Yu. - Stavropol: AGRUS, 2019. - 180 p.
4. Semyonova S.M. et al. Methods for assessing climate change impacts on physical and biological systems. Moscow: Gidrometeoizdat, 2012.
5. Systems of agriculture of Stavropol: monogr. / A. A. Zhuchenko [et al.]; under general ed. A. A. Zhuchenko, V. I. Trukhacheva; StAU. - Stavropol: AGRUS, 2011. - 844 p.
6. Stanovoi ridge of intensive agriculture - crop rotation, fertilization, irrigation: monogram. [In the direction of "Agronomy" and "Ecology and Nature Management"] / V. V. Ageev, A. N. Esaulko, M. S. Sigida, O. Yu. Lobankova; STAU. - Stavropol: AGRUS, 2018. - 356 p.
7. Modern methods of diagnostics of plant nutrition [electronic full text]: methodical instructions in the direction of 35.06.01 - Rural Household, profile 06.01.04 - Agrochemistry / com.: A. N. Esaulko, V. V. Ageev, V. G. Sychev, A. I. Podkolzin, A. A. Kutsenko, Y. I. Grechishkina, M. S. Sigida, O. Yu. A. Belovolova, L. S. Gorbatko, S. A. Korostylev, E. V. Golosnoy, A. Voskoboynikov, E. A. Salenko, A. Yu. Fursova; StAU. - Stavropol: AGRUS, 2015. - 787 KB.

Additional literature (Foreign sources):

1. Agriculture and climate change Challenges and opportunities at the global and local level Collaboration on Climate-Smart Agriculture. Food and Agriculture Organization of the United Nations Rome, 2019
2. Dimeyeva L. A., Sitpayeva Gulnara T., Sultanova B.M. High-Altitude Flora and Vegetation of Kazakhstan and Climate Change Impacts.- May 2015. DOI: 10.1007/978-3-319-12859-7_1
3. Glantz M.H. Climate affairs: a primer. National Center for Atmospheric Research. IslandPress, 2003, 292 p.
4. Influence of methods and technology of nitrogen fertilizer application in early spring fertilization on winter wheat productivity in arid zone of south of Russia / E. Golosnoy, A. Esaulko, A. Belovolova, A. Ozheredova // Engineering for Rural Development. – 2019. – pp. 386-390.
5. Controlling vehicular emissions in Beijing during the last decade. Hao Jiming. Hu Jingnan. Transp. Res. A. 2006. 40, №8, pp.639-651.
6. Condition monitoring and analysis of development in winter crops of water erosion processes using remote sensing technologies / Esaulko A., Sigida M., Golosnoy E., Antonov S., Lobankova O. // Engineering for Rural Development. – 2019. – pp. 391-396.
7. Michal Nachmani, Sam Tucker Landesman, Hitomi Roppongi, Philip Schleifer, Amelia Sharman, K. Stolle Singleton, Jayaraj Sundaresan and Terry Townsend. Climate. Kazakhstan. Extract from 2015 Global Climate Legislation Survey 99 Country Climate Change Legislation Review/ www.lse.ac.uk/GranthamInstitute/legislation

List of electronics data vase and Internet resources necessary for the module study
www.isiknowledge.com
www.scopus.com
https://elibrary.ru/
http://www.fao.org
http://www.mnr.gov.ru
http://www.ecocom.ru/arhiv/ecocom/officinf.html
meteorf.ru

Remote electronic network learning resources of temporary access, formed on the basis of direct contracts with rights holders (electronic library systems - EBS), information and reference systems:
Infra-M Publishing House electronic library system (https://znanium.com)

Lan Publishing House electronic library system (https://e.lanbook.com) Electronic Library System of Yureit Publishing House (https://biblio-online.com) Electronic periodic directory (https://www.garant.ru) World Meteorological Organization http://www.wmo.int/pages/index_ru.html Paris Agreement to the UN Framework Convention on Climate Change http://www.un.org/ru/documents/decl_conv/conv2010.shtml
Other invited experts

6.3. Subtopic organization

3.e. ECTS 0,8	**Contact hrs including academic hrs per week** 6|6	**Grouping** No	**Recommended study semester** 2	**Language** Russian, Kazakh, English
Workload 0,8 ECTS points x 30 academic hours = 24 academic hours **– with the further districution**				
Presence/Contact (lectures, laboratory works, practical studies) 12 hrs. / 50%			**Individual work** (Task or group work, self-study) 12 hrs/ 50%	

6.1. Subtopic description

Code	Subtopic title
Subtopic 2	Climate change effects on food security

6.2. Subtopic design

Learning outcomes
What knowledge and skills should be acquired to achieve the learning objectives of the module?
To which competences will these contribute?

Competence 1 (K1): PhD students are able to conduct complex research including transdisciplinry and apply modern rsearch methods of qualtitative and qualitative aspects of climate change with a view of promoting ahricultural sustainability.
Knowledge 1 (K131): PhD students know advanced modern interdisciplinary theories linking agriculture and climate change: climate models and the impact of climate change on food systems and chains;
Skills1 (K1У1): PhD studemts are able to critically analyze modern scientific research in the field of climate change impact on food security.

Competence 2 (K2): PhD students are able to develop and implement techniques and models of sustainable development of crop and livestock production systems to ensure food security in the face of climate change.
Knowledge 1 (K231): PhD students know risks associated with climate change and their impact on food security;
Skills 2 (K2У2): PhD students are able to apply methods of assesing risks of climate change impact on food security.

Content
What professional, methodological, practical and interdisciplinary content is covered by the subtopic?

The professional content of the sub-topic covers: relevance and theoretical foundations of the sub-topic; scientific nature of the information material.
The methodological content of the sub-topic focuses on knowledge of methods and methodologies of the research sub-topic; understanding of algorithms for interaction of agricultural and food systems in the context of climate change.
The practical content of the sub-topic emphasises the ability to apply methods and tools to study the food security system; the ability to test the results and implement them in model forecast scenarios;
The interdisciplinary content of the sub-topic covers: the fragmentation of research (a combination of the scientific sphere, business participants and government departments); the principle of synergy in the study of the sub-topic (the study of related and highly specialized components of research in total gives a greater effect).

Content:
1. Lecture - discussion: "Social and historical aspects of the global food problem. Losses in agriculture due to climate change"
2. Block Seminar: " Definition of specialization and productive forces in the global food system "
3. Case study: "Economic, environmental, social, natural and climatic, and man-made risks"
4. Self-study of training materials in the form of a group work: " Contemporary trends in ensuring food security through national management systems "
5. Lecture-visualization: "Food supply for humanity at the present stage of development. Reducing losses in agriculture by applying "smart" technologies"
6. Tick-box: "Advanced research related to climate change and food security"
7. Brainstorm: "Population income and economic availability of food"
8. Self study of training materials in the form of supporting notes: "World policy and international activities in the field of food supply in the context of developed and developing countries"

Teaching/learning forms
- lecture - discussion
- lecture-visualization
- block seminar
- case study
- tick-box strategy
- brainstorming

Methods of teaching/learning
Lecture-discussion, visualization lecture, block-seminar, case-study, The use of a tick-box, brainstorming seminars

Literature/ teaching materials
Literature sources:

1. Agroecology. 1. Methodology, technology, economics: textbook for universities of agronomy fields. / Ed. A. Chernikov, ed. A. I. Chekeres. - Moscow: Kolos - Text: - 2004. - 399 p.
2. Declaration of the World Summit on Food Security (Adopted at the World Summit on Food Security, Rome, 16-18 November 2009).

3. Climate change, climate education: training manual for students in training areas 05.03.06 Ecology and nature management, 05.03.02 Geography / Ministry of Science and Higher Education. Russian Federation, Buryat State University named after V.I. Lomonosov, Ministry of Science and Higher Education. Dorzhi Banzarov; compiled by: M. A. Motoshkina, D. M. Ayusheeva. - Ulan-Ude: Buryat State University Publishing House, 2019. - 216 p.

Addititonal literature:
4. Kyoto Protocol (Kyoto Protocol), 1997 Doha Climate Gateway, 2012.
5. Kokorin A.O. Climate change. Glossary of terms used in the UNFCCC [Electronic resource]/A.O. Kokorin, O.N. Lipka, R.V. Sulyandziga. - Moscow: World Wildlife Fund (WWF), 2015. - 93 p.
6. Loginov V.F. Climate Change: Trends, Cycles, Pauses [Electronic Resource]: Monograph / V.F. Loginov, V.S. Mikutsky. - Minsk. 2017. - 179 c. https://e.lanbookcom/book/106670 /
7. Paris Climate Conference (21st Conference held under the UN Framework Convention on Climate Change), 2015.
8. A.G. Paptsov, N.A. Shelamova. World Agrifood System and Global Climate Change // Agricultural Sector: Economics, Management. - – 2017. - – № 11. - – pp. 81–94.
9. Paptsov, A.G. Global food security in conditions of climatic changes: monograph (in Russian) / A.G. Paptsov, N.A. Shelamova. MOSCOW: RUSSIAN ACADEMY OF SCIENCES. - – 2018. - – 132p.
10. The problems of agro-meteorology under conditions of global climate change. "Agrometeorological support for sustainable development of agriculture under conditions of climate change" (Russia, Obninsk, October 2006): scientific publication. Episode. 36 / ed. I. G. Gringof. - Obninsk: [b. and.], 2007. - 461 p.
11. Soil processes and spatio-temporal organization of soils: [a collection of scientific articles] = Soil processes and spatio-temporal organization of soils. - Moscow: Nauka, 2006. - 567, [1] p.
12. Development and Climate Change: World Development Report 2010. - Moscow: Worldwide, 2010. - 440 c.
13. Tulokhonov A. K. Kyoto Protocol: Problems and Solutions: Analytical Review / A. K. Tulokhonov, S. D. Puntsukova, E. M. Zomonova; Siberian Branch of the Russian Academy of Sciences, SPNTB. - Novosibirsk: [b. and.], 2006. - 117 p.
14. Fedorov V.M. Earth Insolation and Modern Climate Change [Electron Resource] / V.M. Fedorov. - Electron. data - Moscow: Fizmatlit, 2018. - 232 p. http://e.lanbookcom/book/105024.
15. Khromov S. P. Meteorology and climatology: Rec. Ministry of Education of the Russian Federation as a textbook for universities in the direction 51140 "Geography and Cartography" and special. 012500, 013700 / S. P. Chromov. - 6th ed., transcript and additional - M.: KolosS; [B. m.]: Moscow State University Publishing House, 2008. - 584 p.
16. Shabanov, V.V. Estimation of natural and economic risk under conditions of climate change (by example of agricultural activity): a training manual / V.V. Shabanov; Aut. S. Orlov. - M. : [s. n.], 2003 - . - Text: P.1: Theory. - 87 p.
17. Shabanov V. V. Assessment of natural and economic risk in conditions of climate change (by example of agricultural activity): a training manual / V. V. Shabanov; Aut. S. Orlov. - M. : [s. n.], 2003 - . - Text P.2: Practice. - 109 p.
18. Ecological Management in a Globalized Economy: an additional UMO education as a training manual for university students of field 080502 / P. V. Sukhorukov. - Moscow: KolosS, 2009. - 216 p.
19. "FAO-Adapt": FAO Framework Programme on Climate Change Adaptation [Electronic Resource]. - URL: http://www.fao. org/docrep/meeting/024/ md323r. Pdf.
20. Official website of the International Centre for Trade and Sustainable Development (ICTSD) [Electronic resource]. - URL: http://www.ictsd.org/bridges-news.

Additional literature (Foreign sources):
1. Nicetic, O. and E. van de Fliert. 2014. Changing institutional culture: participatory monitoring and evaluation in transdisciplinary research for agricultural development in Vietnam. *Knowledge Management for Development Journal* 10(3): 60-68. http://journal.km4dev.org/
2. Strasser, U.; Förster, K.; Formayer, H.; Hofmeister, F.; Marke, T.; Meißl, G.; Nadeem, I.; Stotten, R.; Schermer, M. Storylines of combined future land use and climate scenarios and their hydrological impacts in an Alpine catchment (Brixental/Austria). Sci. Total Environ. 2018. in review.
3. Mina, M.; Bugmann, H.; Cordonnier, T.; Irauschek, F.; Klopcic, M.; Pardos, M.; Cailleret, M. Future ecosystem services from European mountain forests under climate change. J. Appl. Ecol. 2017, 54, 389–401. [CrossRef]
4. Ellison, D.; Morris, C.; Locatelli, B.; Sheil, D.; Cohen, J.; Murdiyarso, D.; Gutierrez, V.; van Noordwijk, M.; Creed, I.; Pokorny, J.; et al. Trees, forests and water: Cool insights for a hot world. Glob. Environ. Chang. 2017, 43, 51–61. [CrossRef]
5. Brown, L.R. 2006. Plan B 2.0: Rescuing a planet under stress and a civilization in trouble. Earth Policy Inst., Washington, DC.
6. Caporali, F., G. Lieblein, P. Von Fragstein, and C. Francis. ed. 2007. Integration of research and education in agroecology and organic farming. In Proc. ENOAT Workshop, Pieve Tesino, Italy. 30–31 Aug. 2007. Dep. Plant Production, Univ. of Tuscia, Viterbo, Italy.
7. Stokols D, Hall KL, Moser RP, Feng A, Misra S, Taylor BK (2010). Evaluating cross-disciplinary team science initiatives: conceptual, methodological, and translational perspectives. In: Frodeman R, Klein JT, Mitcham C (eds) Oxford handbook on interdisciplinarity. Oxford University Press, New York, pp 471–493.
8. Talwar S, Wiek A, Robinson J (2011) User engagement in sustainability research. Sci Public Policy 38:379–390.

9. Clark WC, Tomich TP, van Noordwijk M, Guston D, Catacutan D, Dickson NM et al (2011) Boundary work for sustainable development: natural resource management at the Consultative Group on International Agricultural Research (CGIAR). Proc Natl Acad Sci USA [Epub ahead of print]. doi:10.1073/pnas. 0900231108
10. Cloos L, Trutnevyte E, Bening C, Hendrichs H, Wallquist L, Stauffacher M et al (2010) Energiestrategien kleiner Gemeinden und kleiner und mittlerer Unternehmen. Der Fall Urna¨sch im Kanton Appenzell Ausserrhoden. ETH-UNS Fallstudie 2009. TdLab, Zu.
11. Cox M, Arnold G, Toma´s SV (2010) A review of design principles for community-based natural resource management. Ecol Soc 15(4):38.
12. Methodological challenges of transdisciplinary research Christian Pohl, Gertrude Hirsch Hadorn Dans Natures Sciences Sociétés 2008/2 (Vol. 16), pages 111 à 121.
13. Conventionabout Food assistance http://docs.cntd.ru/document/499077683

The list of electronic bases and Internet resources necessary for mastering the module:
www.isiknowledge.com
www.scopus.com
https://elibrary.ru/
http://www.fao.org
http://www.mnr.gov.ru
http://www.ecocom.ru/arhiv/ecocom/officinf.html
meteorf.ru

Remote electronic network learning resources of temporary access, formed on the basis of direct contracts with rights holders (electronic library systems - EBS), information and reference systems:
Infra-M Publishing House electronic library system (https://znanium.com)
Electronic library system of "Lan" Publishing House (https://e.lanbook.com)
Electronic library system of "Yureit" Publishing House (https://biblio-online.com)
Electronic periodic directory (https://www.garant.ru)

Other
To better understand the lecture material, as well as to gain practical experience in the study of Module 2 sub-theme 2, experts working in the field from Russia, Kazakhstan and the EU will be invited to the classes.

6.3. Subtopic organization

3.e. ECTS	**Presence (including classroom hrs a week)**	**Grouping**	**Study semester recommended**	**Language**
0,8	4|8	No	2	Russian, Kasakh, English

Workload
0,8 ECTS points x 30 academic hours = 24 academic hours **– with the further distribution**

Presence/Contact	**Individual work**
(lectures, laboratory works, practical studies)	(Task or group work, self-study)
12 hrs. / 50%	12 hrs./ 50%

6.1. Subtopic description

Code	**Subtopic title:**
Subtopic 3	Sustainable resources management (water, ecosystems, land management)

6.2. Subtopic design

Learning outcomes

What knowledge and skills must be acquired to achieve the learning goals of the module?

What competencies will they help to acquire?

Competence 2 (K2): PhD students are capable of developing and implementing techniques and models for sustainable development of crop and livestock production systems to ensure food security in the face of climate change.
Knowledge 1 (K231): PhD students know principles of evaluation of natural and economic risks in water and land resources use;
Knowledge 1 (K232): PhD students know sustainability principles, mechanisms and methodological approaches that ensure resource management.
Skills 1 (K2У1): PhD students are able to analyze the degree of agrolandscape sustainability using modern digital information technologies;
Skills 1 (K2У2): PhD students are able to find practical solutions to increase resource sustainability (water resources, ecosystems, land use).

Content

Which professional, methodological, practical and interdisciplinary contents are covered with the sub-topic?

Professional content: Relevance of knowledge of innovative measures to reduce risks in sustainable management, principles of sustainability and assessment of adapted measures of the resource potential of agricultural landscapes, closed-loop economy. Applying a scientific approach to ensuring the sustainability of natural systems.
Methodological content: Knowledge of the methodology for assessing natural and economic, environmental and economic, environmental and hygienic risks. Knowledge of mechanisms and procedures for conducting environmental assessment of agricultural enterprises.
Practical content: Application of modern methods for assessing natural and economic risks in the context of climate change. Conducting agroecological analysis and developing a plan for optimizing agricultural landscapes. Development of measures for sustainable resource management.
Interdisciplinary content: Using environmental and economic approaches to sustainable resource management.

Content:
1. Problem lecture: "Using innovative measures in sustainable use and management of water resources in agriculture (taking into account regional specifics)"
2. Seminar - debate: "Principles of sustainability and evaluation of adaptive measures. Agroecological analysis and development of the plan of agrolandscape optimization"
3. Practical lesson: "Assessment of natural and economic risks in conditions of climate change (by examples of agro-industrial complex)"
4. Independent work (preparation of a presentation): "Sustainable Water Resources Management Strategy"
5. Lecture-visualization: "Soil Resources. Integrated soil fertility management"
6. Seminar-discussion: "Analysis of innovative measures aimed at risk reduction based on the assessment of environmental hazards of land use"
7. Case study: "Development of recommendations on agrolandscapes sustainability based on biota transformation assessment"
8. Self study (preparation of a scientific article): "Problems of sustainable land use (on the example of a region)"

Teaching/learning forms

- problem lecture
- seminar - debate
- hands-on training
- lecture-visualization
- workshop-discussion
- case analysis

teaching/learning methods

Problem lecture, Seminar - debate (problem seminar), Practical classes, Seminar-discussion, Case method

Literature/learning materials

Literature sources:

1. Russian Federation. Ministry of Agriculture. On approval of water quality standards of of water bodies of fishery value, including standards of maximum permissible concentrations of harmful substances in waters of water bodies of fishery value [electronic resource]: Order of the Ministry of Agriculture of Russia from December 13, 2016 № 552 (ed. from 12.10.2018) // Registered with the Ministry of Justice of the Russian Federation January 13, 2017 № 53909 - Access from the reference legal system "Consultant Plus" http://www.consultant.ru/.

2. Water management systems and water use: a textbook / L. D. Ratkovich, V. N. Markin, A. L. Buber [et al.]; Ministry of Education and Science of the Russian Federation, Russian State Agrarian University - K. A. Timiryazev Moscow State Agricultural University. - Moscow: INFRA-M, 2019. - – 452 p.
3. Report on the state, use and protection of water resources / On the state of the environment and nature management in the Stavropol Territory in 2017: a collection of the Ministry of Natural Resources and Environment. Stavropol, 2018. - p. 42-43.
4. Zelenskaya T.G. Modern problems of ecology and nature management: a textbook / T.G. Zelenskaya, E.E. Stepanenko, S.V. Okrut. - Stavropol AGRUS, 2018. - 128 p.
5. Loshakov, A.V. Land reclamation, recultivation and protection [electronic resource]: an educational and methodical textbook for post-graduates (in Russian) / Loshakov, A.V. et al. - STAU. - Stavropol : AGRUS, 2015. - 650KB.
6. Okrut S.V. Environmental audit and certification: a training manual / S.V. Okrut, T.G. Zelenskaya, E.E. Stepanenko, O.Yu. - Stavropol, 2019. - 104 p
7. Okrut S.V. Ecological problems of the water objects in the rural areas / S.V. Okrut, Yu.V. Khmelianchishen // Actual problems of ecology and nature use: a collection of scientific papers on the materials of the v international scientific-practical conference (Stavropol, 2017) / StAU. - Stavropol, 2017. - p. 242.
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9. Suslov O.N. Steppe Rivers of the Krasnodar Territory: Monograph. - Krasnodar, KubAU, 2015. - – 256 p.
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2. Biomonitoring of Environment [Text]: textbook for students and graduate students / R.R.Beisenova, L.V.Kubrina, E.V.Donets, A.I.Grigoriev - Almaty: Evero, 2015.- 184 p.: 1, 91 MB.
3. Burlibayev M.J., Volchok A.A., and Shvedovsky P.V. Problems of optimizing nature management and environmental management in mathematical models and methods.- Almaty: Kanagat, 2003. - – 532 p.
4. The Water Code of the Republic of Kazakhstan (as amended and supplemented as of 26.11.2019)
5. Espolov, T.I. Land Resources Management [electronic resource] / T.I. Espolov, J.T. Seyfullin - Almaty, 2004.- 332 p.: 61, 7 mb.
6. Espolov, T.I. Economic and legal mechanism of land resources management [electronic resource]: textbook for universities / T.I. Espolov, J.T. Seifullin, G.J. Seitkhamzina; MES RK; KazNAU.- Almaty: Agrouniversity, 2006.- 316 p.: 54, 9 Mb.
7. Zubairov, O.Z. Wastewater and its use in agriculture [Electron resource]: monograph / O.Z. Zubairov.- Almaty: KazNAU, 2011.- 289s.
8. Korpachev V.P. Water resources and basics of water management [Electron resource]: a training manual - 3rd, correct and additional - CD-RW 700 MB/80 MIN.- SPb.: Lan, 2012.- 320 p.
9. Mustafayev J.S. Methodological and ecological principles of agricultural land reclamation. - Taraz, 2004. - – 306 p.
10. Narbayev T.I. Hydrology, Textbook for Rivers Higher Educational Institutions. Ministry of Education and Science of the RK, 2014.
11. Normalization and reduction of environmental pollution [Electronic resource]: a textbook / Ya.D.Vishnyakov, N.N.Burtseva, S.P.Kisilyova [etc.]; edited by Ya.D.Vishnyakov.- M.: Academy, 2015.- 368 p.: 8, 56 MB - (Higher education. Bachelor's degree).
12. Sergaliev, N.H. Estimation of the soil emission of the carbon dioxide in different prices of Western Kazakhstan: monograph / N.H. Sergaliev, A.G. Nagiyeva. - Uralsk: West-Kazakhstan agrarian-technical unit named after N.H. Sergaliev / N.H. Sergaliev, A.G. Nagiyeva. Zhangir khan. 2020. - – 113 c
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1. lysenko L. Methodology of forecasting and planning of environmental activities in rural areas// L. lysenko, A. Esaulko , S. Serikov , S. Okrut S., Y. Mandra. – Agricaltural Bulletin of Stavropol Region/ 2015. – Vol/ S1/ - P.- 112-115.
2. Mike, A. Management Planning for Nature Conservation a Theoretical Basis & Practical Guide / A. MiKe.F-Springer Netherlands, 2013. - 508 p.
3. Costa, R. T. Land Use / Cover and Naturalness Changes for Watershed Environmental Management (Southeastern Brazil) / R. T. Costa C.F. Goncalves, A. T. Fushita J. E. dos Santos // Journal of Geoscience and Environment Protection. - 2017. - Vol. 5. - P. 1- 14.
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6. N.Sergaliyev, A.Nagiyeva, A. Tlepov. Biological activity and emission of carbon dioxide from dark chestnut soil of Western Kazakhstan. Eco. Env. & Cons. 26 (3) : 2020; pp. (1217-1220) Copyright@ EM International. ISSN 0971–765X. Ecology, Environment and Conservation (0971765X-India-Scopus)

7. Iysenko L. Methodology of forecasting and planning of environmental activities in rural areas// L. Iysenko, A. Esaulko , S. Serikov , S. Okrut S., Y. Mandra. – Agricaltural Bulletin of Stavropol Region/ 2015. – Vol/ S1/ - P.-112-115.

8. Mike, A. Management Planning for Nature Conservation a Theoretical Basis & Practical Guide / A. MiKe.F-Springer Netherlands, 2013. - 508 p.

9. Costa, R. T. Land Use / Cover and Naturalness Changes for Watershed Environmental Management (Southeastern Brazil) / R. T. Costa C.F. Goncalves, A. T. Fushita J. E. dos Santos // Journal of Geoscience and Environment Protection. - 2017. - Vol. 5. - P. 1- 14.

10. Okrut S. Role of Soil Condition Assessment In The Development Of Farming Biologization Techniques / E.E. Stepanenko, O. Yu. Gudiev, T.G. Zelenskaya, A.O. Kasatkina // Research Journal of Pharmaceutical, Biological and Chemical Sciences. 2018. № 9(6). P. 1813–1818.

Other
Colloquium

6.3. Subtopic organization

3.e. ECTS	**Presence (including classroom hrs a week)**	**Grouping**	**Study semester recommended**	**Language**
0,8	4|8	no	2	Russian, Kasakh, English

Workload
0,8 ECTS points x 30 academic hours = 24 academic hours **– with the further distribution**

Presence/Contact	**Individual work**
(lectures, laboratory works, practical studies) 12 hrs. / 50%	(Task or group work, self-study) 12 hrs./ 50%

6.1. Subtopic description

Code	Subtopic title
Subtopic 4	Environmentally friendly crop production (healthy agricultural products)

6.2. Subtopic design

Learning outcomes

What knowledge and skills must be acquired to achieve the learning goals of the module?
What competencies will they help to acquire?

Competence 1 (K1): PhD students are able to conduct complex research including transdisciplinry and use modern rsearch methods of qualtitative and qualitative aspects of climate change with a view of promoting ahricultural sustainability.
Knowledge 1 (K131): PhD students know advanced modern interdisciplinary theories and new research methods linking the production of environmentally friendly crop products and climate change
Skills1 (K1У1): PhD students are able to conduct comprehensive assessment of agricultural lands for their suitability for environmentally safe crop production;

Competence 2 (K2): PhD students are capable of developing and implementing techniques and models for sustainable development of crop and livestock production systems to ensure food security in the face of climate change.
Knowledge 1 (K231): PhD students know scientific and methodological approaches to development of ecologically safe crop production system;
Skills 1 (K2У1): PhD students are able to apply environmental approaches to plant nutrition and protection in the face of climate change.

Content

What professional, methodological, practical and interdisciplinary content is covered by the sub-theme?

Professional content: Theories and models of sustainable agricultural development in the application of environmentally safe crop production in the context of climate change.
Main components of environmentally friendly crop production systems based on observations, measurements, information, academic resources, calculations, and concepts of functioning of environmentally friendly farming systems;
Efficiency of agricultural systems in terms of the balance of natural resources, labor, and agroeconomics.
Program-target approach to sustainable development of organic agriculture in organic production management.
Fundamentals of planning and forecasting sustainable agricultural development and identification of differences between traditional farming and organic farming
The methodological content of the sub-topic covers: Knowledge of methods and methodologies of the research sub-topic; Understanding of the algorithm for producing environmentally friendly products and climate change.
The practical content of the sub-topic focuses on developing the ability to apply methods and tools for the production of environmentally friendly products; developing the ability to test the results and implement them in model predictive scenarios; Personal integration of the student into the research process of the sub-topic (equal participation)
The interdisciplinary content of the sub-topic covers fragmentation of research (a combination of the scientific sphere, business participants and government departments); the principle of synergy in the study of the sub-topic (the study of related and highly specialized components of research); Integration of different Sciences in one sub-topic (biology (agriculture), Economics, sociology).

Content:
1. Lecture-visualization: "Biological protection of plants"
2. Practice-oriented lesson: "Features of obtaining environmentally friendly products"
3. Practical lesson with the involvement of expert practitioners: "Production and introduction of microbiological preparations for plant production"
4. Independent study of training materials in the form of group work: "Measures to ensure stabilization of agroecosystem productivity and biodiversity conservation in modern organic agriculture"
5. Lecture - discussion: "Breeding as a tool for maintaining sustainability and safety of crop production"
6. Seminar-conference: "Development of ecological agrochemistry"
7. Case study: "Ecological risks of agro-technologies"
8. Independent study of training materials in the form of supporting notes: "Sanitary and hygienic assessment of food raw materials and food products of plant growing. Substances that contaminate foodstuffs and forages".

Teaching/learning forms

- lecture-visualization
- hands-on training
- hands-on training involving expert practitioners
- lecture - discussion
- workshop-conference
- case study

Teaching/learning methods
Visualization lecture, practice-oriented lesson, practical training, lecture-discussion, seminar-conference, case-study method

Literature/learning materials
Literary sources:

1. System of Agriculture of the Buryatia Republic: scientific and practical recommendations/; under scientific editorship of Professor A. P. Batudaev. -2nd ed., transcript and additional. -Ulan-Ude: Publishing house of V. R. Filippov BGSHA, 2018. -349 p.
2. Tushkanov M.P. Organization of agricultural production: Textbook / M.P. Tushkanov, S.I. Gryadov. - 1. - Moscow: "INFRA-M Research and Publishing Center", 2019. - 292 p.
3. Textbook on organic agriculture / Candidate of Agricultural Sciences A. Nersisyan / Food and Agricultural Organization of the United Nations. Regional Office for Europe and Central Asia - Budapest, 2017 - 118 p.
4. Shchukin S.V. Ecologization of agriculture (conversion of traditional agriculture into organic one) [Text] / Training manuals series "RUDECO Retraining in the field of rural development and ecology" M., 2012. - – 196 p.
Additional literature:
1. G. U. Akimbekova, Sh. U. Akimbekova, V. V. Grigoruk, E. Klimov. V., Moldashev A. B., Nikitina G. A. Horticultural Cooperation of Kazakhstan. Methodical manual 2017. UDC 635: 334.73 (574).
2. Forest N.N. Production of ecologically clean crop products: Ecological bases of cereal crops straw utilization. Module 12: Training Manual / N.N. Lesnoy, Grigorov A.N. - M.: ONTI PNC RAS, 2001. - 33 p.
3. Tulokhonov A. K. Kyoto Protocol: Problems and Solutions: Analytical Review / A. K. Tulokhonov, S. D. Puntsukova, E. M. Zomonova; Siberian Branch of the Russian Academy of Sciences, GPNTB. - Novosibirsk: [b. and.], 2006. - 117 p.
4. Shabanov V. V. Assessment of natural and economic risk in conditions of climate change (on the example of agricultural activity): a training manual / V. V. Shabanov; Avt. S. Orlov. - M. : [s. n.], 2003 - . - Text: P.1 : Theory. - 87 p.
5. Shabanov V. V. Assessment of natural and economic risk in conditions of climate change (by example of agricultural activity): a training manual / V. V. Shabanov; Aut. S. Orlov. - M. : [s. n.], 2003 - . - Text P.2: Practice. - 109 p.
6. Ecological Atlas of the Baikal Basin // site of the Baikal Information Center. URL: http://archive.iwlearn.net/bic.iwlearn.org/bic.iwlearn.org/bic.iwlearn.org/ru/atlas/atlas.html

Aditional literature (Foreign sources):

1. Nicetic, O. and E. van de Fliert. 2014. Changing institutional culture: participatory monitoring and evaluation in transdisciplinary research for agricultural development in Vietnam. *Knowledge Management for Development Journal* 10(3): 60-68. http://journal.km4dev.org/
2. Strasser, U.; Förster, K.; Formayer, H.; Hofmeister, F.; Marke, T.; Meißl, G.; Nadeem, I.; Stotten, R.; Schermer, M. Storylines of combined future land use and climate scenarios and their hydrological impacts in an Alpine catchment (Brixental/Austria). Sci. Total Environ. 2018. in review.
3. Mina, M.; Bugmann, H.; Cordonnier, T.; Irauschek, F.; Klopcic, M.; Pardos, M.; Cailleret, M. Future ecosystem services from European mountain forests under climate change. J. Appl. Ecol. 2017, 54, 389–401. [CrossRef]
4. Ellison, D.; Morris, C.; Locatelli, B.; Sheil, D.; Cohen, J.; Murdiyarso, D.; Gutierrez, V.; van Noordwijk, M.; Creed, I.; Pokorny, J.; et al. Trees, forests and water: Cool insights for a hot world. Glob. Environ. Chang. 2017, 43, 51–61. [CrossRef]
5. Brown, L.R. 2006. Plan B 2.0: Rescuing a planet under stress and a civilization
in trouble. Earth Policy Inst., Washington, DC.
6. Caporali, F., G. Lieblein, P. Von Fragstein, and C. Francis. ed. 2007. Integration of research and education in agroecology and organic farming. In Proc. ENOAT Workshop, Pieve Tesino, Italy. 30–31 Aug. 2007. Dep. Plant Production, Univ. of Tuscia, Viterbo, Italy.
7. Stokols D, Hall KL, Moser RP, Feng A, Misra S, Taylor BK (2010). Evaluating cross-disciplinary team science initiatives: conceptual, methodological, and translational perspectives. In: Frodeman R, Klein JT, Mitcham C (eds) Oxford handbook on interdisciplinarity. Oxford University Press, New York, pp 471–493.
8. Talwar S, Wiek A, Robinson J (2011) User engagement in sustainability research. Sci Public Policy 38:379–390.
9. Clark WC, Tomich TP, van Noordwijk M, Guston D, Catacutan D, Dickson NM et al (2011) Boundary work for sustainable development: natural resource management at the Consultative
Group on International Agricultural Research (CGIAR). Proc Natl Acad Sci USA [Epub ahead of print]. doi:10.1073/pnas. 0900231108
10. Cloos L, Trutnevyte E, Bening C, Hendrichs H, Wallquist L, Stauffacher M et al (2010) Energiestrategien kleiner Gemeinden und kleiner und mittlerer Unternehmen. Der Fall Urna¨sch im Kanton Appenzell Ausserrhoden. ETH-UNS Fallstudie 2009. TdLab, Zu.
11. Cox M, Arnold G, Toma´s SV (2010) A review of design principles for community-based natural resource management. Ecol Soc 15(4):38.
12. Methodological challenges of transdisciplinary research Christian Pohl, Gertrude Hirsch Hadorn Dans Natures Sciences Sociétés 2008/2 (Vol. 16), pages 111 à 121.
13. Hamza M.A., Anderson W.K .. Soil compaction in crop-ping systems: A review of the nature, causes and possible solutions. Soil and Tillage Research, 82 (2), 121-145.

14. Stoate C., Boatman N. D., Borralho R. J., Carvalho C. Rio, G. R. de Snoo and Eden P. (2001). Ecological impacts of arable intensification in Europe. Journal of Environmental Management, 63 (4), 337-365.
15. Altaeva O A, Imeskenova and Chibikova O.M.. Sustainable development of organic agriculture in the Baikal region, as a cross-border area. 2019 – To cite this article: O A Altaeva et al 2019 IOP Conf. Ser.: Earth Environ. Sci. 395 012006. https://iopscience.iop.org/issue/1755-1315/395/1
16. Problems of economic regionalization in modern conditions / Ts. D. Gonchikov [et al.] // Environment and Sustainable Development of the Mongolian Plateau and Adjacent Territories: proceedings of the XII International Scientific Conference (Ulan-Ude, August 3-4, 2017). - 2017. - pp. 184-186.

The list of electronic bases and Internet resources necessary for mastering the module:
www.isiknowledge.com
www.scopus.com
https://elibrary.ru/
http://www.fao.org
http://www.mnr.gov.ru
http://www.ecocom.ru/arhiv/ecocom/officinf.html
meteorf.ru
https://soz.bio/spravochnye-dannye-ob-organicheskom-selskom-hozyajstve-v-rossii/

Remote electronic network learning resources of temporary access, formed on the basis of direct contracts with rights holders (electronic library systems - EBS), information and reference systems:
Infra-M Publishing House electronic library system (https://znanium.com)
Electronic library system of "Lan" Publishing House (https://e.lanbook.com)
lectronic library system of "Lan" Publishing House (https://biblio-online.com)
Electronic periodic directory (https://www.garant.ru)

Others
For better understanding of the lecture material, as well as for practical experience in the study of sub-theme 4 of Module 2, experts working in the field from Russia, Kazakhstan and the EU will be invited to the classes.

6.3. Subtopic organization

3.e. ECTS 0,8	**Presence (including classroom hrs a week)** 4\8	**Grouping** no	**Study semester recommended** 2	**Language** Russian, Kasakh, English
Workload 0,8 ECTS points x 30 academic hours = 24 academic hours **– with the further distribution**				
Presence/Contact (lectures, laboratory works, practical studies) 12 hrs. / 50%			**Individual work** (Task or group work, self-study) 12 hrs./ 50%	

6.1. Subtopic description

Code	**Subtopic title**
Subtopic 5	Sustainable livestock systems and animal welfare

6.2. Subtopic design

Learning outcomes

What knowledge and skills must be acquired to achieve the learning goals of the module?
What competencies will they help to acquire?

Competence 2 (K2): PhD students are capable of developing and implementing techniques and models for sustainable development of crop and livestock production systems to ensure food security in the face of climate change.
Knowledge 1 (K2Z1): PhD students know the stress and adaptation in livestock production; Animal welfare concept; Principles and criteria for assessing welfare;
Knowledge 2 (K2Z2): PhD students know the impact of livestock farming on the environment; main factors affecting the adaptation of livestock farming systems to climate change.
Skills 1 (K2U1): PhD students are able to characterize high- and low-intensity livestock production models; to discuss animal welfare problems; to assess animal welfare;
Skills 2 (K2U2): PhD students are able to assess the environmental impact of livestock production; describe high- and low-intensity livestock production models in the context of climate change; identify the main factors affecting the adaptation of livestock production systems to climate change.

Content

What professional, methodological, practical and interdisciplinary content is covered by the sub-theme?

Professional content covers the impact of environmental conditions on animal production systems, principles and criteria for assessing animal welfare.
Interdisciplinary content focuses on the components and conditions of sustainable development.
In order to achieve sustainable livestock production, students must develop a comprehensive picture of sustainable livestock production systems; be able to evaluate identified strengths and weaknesses of different systems.

Content:
1. Lecture-discussion: "Principles of sustainable animal husbandry"
2. Practical training with the involvement of expert practitioners: "risk Factors for reducing well-being in the context of climate change"
3. Round table: "Adaptation of the livestock system to climate change"
4. Independent work-development of a research project, preparation of a selection and breeding plan: "Improvement of innovative technologies in animal husbandry in connection with climate change"
5. Problem lecture: "animal Welfare and its components"
6. Practice-oriented lesson (departure to the enterprise): "Quality management model of management processes in animal husbandry" - 2 hours (Bostanova Saule)
7. Seminar-conference "Ecological consequences of modern methods of animal husbandry"
8. Independent work-preparation of a scientific article (thesis): "Animal husbandry and the natural environment"

Teaching/learning forms

- lecture-discussion;
- practical exercise involving expert practitioners
- problem lecture
- hands-on training
- seminar-conference
- round table

Teaching/learning methods

Lecture-discussion, Problem lecture, practical session, Practice-oriented training, Round table, seminar-conference, Development of a research project.

Literature/learning materials

Literary sources:

1. Ivanov Yu.A., Mironov V.V. Ecological animal husbandry, problems and challenges. Collection of Scientific Proceedings: 0131-5226. 2015. issue 87.
2. Raimov U.B. Influence of climate change on animal husbandry, pasture management and adaptation technologies to improve and restore degraded lands. Practical Guide. Bishkek, 2019.
3. The role of livestock in sustainable agricultural evelopment for food security and nutrition/Report of the High Level Panel of Experts on Food Security and Nutrition / July 2016
4. Raimov U. B. Influence of climate change on animal husbandry, pasture management and adaptation technologies to improve and restore degraded lands. Practical Guide. Bishkek, 2019.

Additional reference materials (Foreign sources):

1. Abubakar, M., Manzoor, S., Iqbal, A., 2018. Introductory Chapter: Animal Welfare—Global Perspective, Animal Welfare, IntechOpen
2. Graux, A., Lardy, R., Bellocchi, G., Soussana, J.F. Global warming potential of French grassland-based dairy livestock systems under climate change (Article). Regional Environmental ChangeVolume 12, Issue 4, 2012, Pages 751-763.
3. Pig environment problems/ P.Smith, H.Crabtree. –Nottingham, 2005. – 166 p.
4. Sustainable animal production/Ed. A.Aland and F.Madec. Wageningen, 2009.- 496 p.
5. Sustainable farm production/ M.Krause, J.Richardson. Inkata Press. 1996. - 143 p.
6. FAO. 2018. World Livestock: Transforming the livestock sector through the Sustainable Development Goals. Rome. - 222 pp. Licence: CC BY-NC-SA 3.0 IGO.
7. ФАО. 2020. Здоровье животных и изменение климата. Рим. - 8 с. Licence: CC BY-NC-SA 3.0 IGO.
8. Food and Agriculture Organization (2006) Livestock's Long Shadow. Rome: Food and Agriculture Organization.
9. World Bank (2009) Minding the Stock: Bringing Public Policy to Bear on Livestock Sector Development. Washington: The WorldBank.

The list of electronic bases and Internet resources necessary for mastering the module:
www.isiknowledge.com
www.scopus.com
https://elibrary.ru/
http://www.fao.org
http://www.mnr.gov.ru
http://www.ecocom.ru/arhiv/ecocom/officinf.html
meteorf.ru

Remote electronic network learning resources of temporary access, formed on the basis of direct contracts with rights holders (electronic library systems - EBS), information and reference systems:
Infra-M Publishing House electronic library system (https://znanium.com)
Electronic library system of "Lan" Publishing House (https://e.lanbook.com)
Electronic library system of "Yureit" Publishing House (https://biblio-online.com)
Electronic periodic directory (https://www.garant.ru)

Others
practical visits: a field trip to a livestock farm

6.3. Subtopic organization

3.e. ECTS	**Presence (including classroom hrs a week)**	**Grouping**	**Study semester recommended**	**Language**
0,8	4|8	np	2	Russian, Kasakh, English

Workload
0,8 ECTS points x 30 academic hours = 24 academic hours **– with the further distribution**

Presence/Contact	**Individual work**
(lectures, laboratory works, practical studies) 12 hrs. / 50%	(Task or group work, self-study) 12 hrs./ 50%

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History of changes		
Version	**Publication date**	**Change**
1.1.	17.11.2021	Initial version