SULAWE Module description

Code	Title of the module
Module 3	**Digital Livestock Farming**

1. Learning Objectives of the Module

Qualification objectives The formation of knowledge, skills and abilities related to the implementation of digital technologies in animal husbandry among students of higher education.
Summary of the Content Which professional, methodological, practical and interdisciplinary contents will be delivered? Digitalization of animal husbandry includes the use of modern digital technologies to improve management and monitoring of animal husbandry and optimize production processes on farms. The study of the subtopic Introduction to Digital Livestock Farming will acquaint students with digital technologies in livestock farming, with its advantages and disadvantages, and will form a theoretical basis for students to study the discipline. Technological Basics for Digital Agriculture and Smart Livestock Farming will enable students to gain knowledge about telemetry devices for measuring indicators of physiological state, health and productivity. Application of Digital Technologies in Livestock Production for increasing sustainability and animal welfare will introduce students to the monitoring of ethological indicators related to animal welfare. Automation and Robotics in Livestock Production deals with automation systems for feeding, milking and animal care, Management Information Systems in Livestock Farming with livestock production management software. The acquired knowledge will allow the students to form a theoretical base and practical skills in the use of digital technologies in production. It will allow students to familiarize themselves with the latest technologies and develop strategies for improving management and optimizing production at livestock enterprises.
Teaching/learning forms (summary) Lecture, lab work, individual work (including the control task).

2. Preconditions for participation

Knowledge, skills, competences	Which knowledge, skills, competences are required for successful participation? For specialty 204 “Technology of livestock production”: Knowledge of the disciplines included in the entrance exam: Animal feeding and feed technology; Hygiene of farm animals; Breeding of farm animals; Milk and beef production technology; Technology of pig farming; Poultry production technology. For specialty 211 “Veterinary medicine”: Knowledge obtained during completion of secondary education.
Preparation for the module	RISE

	https://www.bfh.ch/en/research/all-our-consulting-services/rise/ Pezzuolo, A., Guo, H., Marchesini, G., Brscic, M., Guercini, S., & Marinello, F. (2021, November). Digital technologies and automation in livestock production systems: A digital footprint from multisource data. In *2021 IEEE International Workshop on Metrology for Agriculture and Forestry (MetroAgriFor)* (pp. 258-262). IEEE. doi: https://doi.org/10.1109/MetroAgriFor52389.2021.9628544 . Sarkar, A., Wang, H., Rahman, A., Memon, W. H., & Qian, L. (2022). A bibliometric analysis of sustainable agriculture: based on the Web of Science (WOS) platform. *Environmental Science and Pollution Research*, *29*(26), 38928-38949. https://doi.org/10.1007/s11356-022-19632-x Varijakshapanicker, P., Mckune, S., Miller, L., Hendrickx, S., Balehegn, M., Dahl, G. E., & Adesogan, A. T. (2019). Sustainable livestock systems to improve human health, nutrition, and economic status. *Animal Frontiers*, *9*(4), 39-50. https://doi.org/10.1093/af/vfz041 Michalk, D. L., Kemp, D. R., Badgery, W. B., Wu, J., Zhang, Y., & Thomassin, P. J. (2019). Sustainability and future food security—A global perspective for livestock production. *Land Degradation & Development*, *30*(5), 561-573. https://doi.org/10.1002/ldr.3217 Inna, L., Lukash, S., Nataliia, M. H., & Alina, B. (2021). Digitalization, Robotics, and Genomic Research in Livestock Development. *International Journal of Business Analytics (IJBAN)*, *8*(2), 38-45. https://doi.org/10.4018/IJBAN.2021040103 Neethirajan, S.; Kemp, B. Digital Livestock Farming. Sensing and Bio-Sensing Research, 2021, 32, 100408. https://doi.org/10.1016/j.sbsr.2021.100408 . R. Kasareddy and A. Mukhopadhyay, "FPMS: A Fog based Poultry Monitoring System," *2022 IEEE 2nd Mysore Sub Section International Conference (MysuruCon)*, Mysuru, India, 2022, pp. 1-6, doi: 10.1109/MysuruCon55714.2022.9972632.

3. Module references to sustainable development

Content
Which economic, ecological, social aspects of sustainable development will be treated?

Digital Livestock Farming technologies directly contribute to sustainable development. The application of digital technologies increases economic efficiency and reduces negative environmental effects (nutrient losses, gas emission etc.) of animal production. It also contributes to the improvement of animal welfare and the working conditions of farm laborers.

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

Type and duration (min)	**Share %**
Lab. works defense (90) Test (90)	50 % 50 %

5. Organisation

Responsible for the module PSAU: Prof. Dr. Pavlo Vashchenko LNUVMB: PhD Ihor Dvylyuk NUBiP: PhD Mykhailo Matvieiev		
Type of the module PSAU and LNUVMB: compulsory NUBiP: elective	**Regular cycle** Annually	**Duration** 1 Semester
Admission requirements 204: Bachelor's degree 211: completed secondary education	**ECTS-points** 4 ECTS	**Presence on semester week hours** 3
Workload 4 ECTS-Points x 30 hours = 120 hours – **total workload, with the following allocation**		
Presence/Contacts 40-60 hours. / 33-50%	**Preparation/ follow up/ self-study** 80-60 hours. / 67-50%	**Tasks/Group work** 0-20 hours. / 0-17%

6. Design of the module

Sub-topics	
1	Introduction to Digital Livestock Farming
2	Technological Basics for Digital Livestock Farming
3	Application of Digital Technologies in Livestock Production for increasing sustainability and animal welfare
4	Automation and Robotics in Livestock Production
5	Management Information Systems in Livestock Farming

6.1. Subtopic description

Code	Title of the sub-topic
Subtopic 1	Introduction to Digital Livestock Farming

6.2. Design of the sub-topic

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

After completion of the subtopic students know the basic concept of digital farming. They have systematic knowledge about digital tools and technologies used in livestock farming and are able to assess and discuss the effects of digitalization in animal farming. They know about the potential of digital technologies for improving animal welfare and sustainability of production.

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

- Basic concepts of digital livestock farming
- Effects of digital livestock farming technologies on production efficiency, labor, animal health and welfare, sustainability of production
- Practical examples of digital livestock farming systems in cattle/milk, pig and poultry production
- Evolution of digital farming systems (Precision – Smart – Digital Farming)
- Overview about the components of digital livestock farming systems (sensors, databases, automation, software, artificial intelligence)

Teaching/Learning forms
Lecture, excursions, exercises

Teaching/Learning methods
Lecture, presentation, discussion

Literature/ learning materials
Dörr, J. & Nachtmann, M. (2022) Handbook „Digital Farming: Digital Transformation for Sustainable Agriculture“. 1ed, Springer Verlag

Other
Farm visits, guest lecturers

6.3. Organisation of the sub-topic

ECTS-Points	Semester week hours	Grouping/	Reccommended study semester	Language
0,4		No	1	Ukrainian/ English

Workload
0.4 ECTS-Points x 30 hours = 12 hours, **with the following allocation**

Lectures	Practical Tasks/Group work	Preparation/ follow up/ self-study
2 hours / 16,5%	2 hours / 16,5%	8 hours / 66 %

6.1. Subtopic description

Code	Title of the sub-topic
Subtopic 2	Technological Basics for Digital Livestock Farming

6.2. Design of the sub-topic

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

Students understand the technical components of Digital Farming systems in animal production and their functionality, they demonstrate the ability to analyze critically the contemporary problems of digital technologies in agriculture.
Students know advanced digital technologies and techniques applied in the livestock farming sector, they know and understand current trends and developments in digital technologies.
Students are able to use and operate basic Digital Farming equipment and digital technologies in animal production, they are able to evaluate them and to use the results obtained for research purposes.

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

- Technical components of digital farm systems – their functionality, operation and application
  - Sensors, cameras, robots, process control systems
  - Animal identification, data recording and evaluation, Artificial Intelligence
- Practical examples for the application of digital technologies in cattle/milk, pig and poultry production
  - Health control
  - Pasture management
  - Automated milking systems
  - Herd management systems
  - Climate control
- Application of digital technologies in other areas of livestock farming
  - Smart beekeeping;
  - Digital technologies in fish farming and aquaculture.

Teaching/Learning forms
Lecture, excursions, exercises

Teaching/Learning methods
Lecture, presentation, discussion, demonstrations

Literature/ learning materials
Džermeikaite, K., Baceninaite D., Antanaitis R. (2023) Innovations in Cattle Farming: Application of Innovative Technologies and Sensors in the Diagnosis of Diseases. Animals. 13, 780. https://doi.org/10.3390/ani13050780
Halachmi I., Guarino M., Bewley J. and Pastell M. (2019) Smart Animal Agriculture: Application of Real-Time Sensors to Improve Animal Well-Being and Production. Annu. Rev. Anim. Biosci. 7. 403–25. https://doi.org/10.1146/annurev-animal-020518-114851
Herlin A., Brunberg E., Hultgren J., Högberg N., Rydberg A., Skarin A. (2021) Animal Welfare Implications of Digital Tools for Monitoring and Management of Cattle and Sheep on Pasture. Animals. 11. 829. https://doi.org/10.3390/ani11030829
Huet J.-C., Bougueroua L., Kriouile Y., Wegrzyn-Wolska K., Ancourt C. (2022) Digital Transformation of Beekeeping through the Use of a Decision Making Architecture. Appl. Sci. 12. 11179. https://doi.org/10.3390/app122111179

Neethirajan S. (2023) Artificial Intelligence and Sensor Technologies in Dairy Livestock Export: Charting a Digital Transformation. Sensors. 23. 7045. https://doi.org/10.3390/s23167045

Neethirajan S., Kemp B. (2021)Digital Livestock Farming. Sensing and Bio-Sensing Research. 32. 100408. https://doi.org/10.1016/j.sbsr.2021.100408

Neethirajan S., Reimert I., Kemp B. (2021) Measuring Farm Animal Emotions-Sensor-Based Approaches. Sensors. 21. 553. https://doi.org/10.3390/s21020553

Pinna D., Sara G., Todde C., Atzori AS., Artizzu V., Spano LD & Caria M.. (2023) Advancements in combining electronic animal identification and augmented reality technologies in digital livestock farming. Scientific Reports. 13. 18282 https://doi.org/10.1038/s41598-023-45772-2

Rowan N. J. (2023) The role of digital technologies in supporting and improving fishery and aquaculture across the supply chain – Quo Vadis? Aquaculture and Fisheries. 8. 365–374. https://doi.org/10.1016/j.aaf.2022.06.003

Other
Farm visits, guest lecturers

6.3. Organisation of the sub-topic

ECTS-Points	**Semester week hours**	**Grouping/**	**Reccommended study semester**	**Language**
0,6		No	1	Ukrainian/ English

Workload
0,6 ECTS-Points x 30 hours = 18 hours, **with the following allocation**

Lectures	**Practical Tasks/Group work**	**Preparation/ follow up/ self-study**
2 hours / 12%	4 hours / 22%	12 hours / 66 %

6.1. Subtopic description

Code	Title of the sub-topic
Subtopic 3	Application of Digital Technologies in Livestock Production for increasing sustainability and animal welfare

6.2. Design of the sub-topic

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

Students understand Digital Livestock Farming systems and can use digital techniques in cattle/milk, pig and poultry production to solve problems. They know the tendencies in Digital Farming technologies in livestock production; know the scope and methods of production management of the parameters of technological processes during the operation of machinery and equipment. They are able to evaluate and asses the effects of digital production technologies on animal welfare and sustainability of livestock farming. The students are able to operate selected Digital Farming equipment.

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

- Practical application of digital technologies in dairy farming
  - Monitoring of the physiological condition of cows and detection of oestrus
  - Remote identification of animals using chips
  - Automated accounting of cow productivity
- Elements and examples of practical application for precision poultry production
  - Thermal imaging to assess distress in chickens
  - Digital image analysis to estimate the live weight of broilers
  - Image analysis for evaluating young chick's behaviour
  - Infrared thermography for evaluation of heat loss in chickens
- Practical application of digital technologies in livestock production
  - Monitoring the health of calves using sensors (Calf monitoring)
  - Monitoring swine welfare with digital technologies (Lameness, Body condition scoring, prolapse syndrome, welfare at the group level)
  - Identification of pigs with radio frequency identification (RFID chip), optical character recognition, and facial recognition
  - Monitoring temperature, humidity, CO2 and light using wireless sensor networks in pig farms

Teaching/Learning forms
Lecture, excursions, exercises

Teaching/Learning methods
Lecture, presentation, discussion, case studies

Literature/ learning materials
Benjamin, M., & Yik, S. (2019). Precision Livestock Farming in Swine Welfare: A Review for Swine Practitioners. *Animals*, *9*(4), 133. Retrieved from http://dx.doi.org/10.3390/ani9040133

Buller, H., Blokhuis, H., Lokhorst, K., Silberberg, M., & Veissier, I. (2020). Animal Welfare Management in a Digital World. *Animals*, *10*(10), 1779. Retrieved from http://dx.doi.org/10.3390/ani10101779

Corkery, G., Ward, S., Kenny, C., & Hemmingway, P. (2013). Incorporating smart sensing technologies into the poultry industry. Journal of World's poultry research, 3(4), 106-128.

Groher, T., Heitkämper, K., & Umstätter, C. (2020). Digital technology adoption in livestock production with a special focus on ruminant farming. Animal, 14(11), 2404-2413. doi: http://dx.doi.org/10.1017/S1751731120001391
Other Farm visits, guest lecturers

6.3. Organisation of the sub-topic

ECTS-Points 1.0	**Semester week hours**	**Grouping/** No	**Reccommended study semester** 1	**Language** Ukrainian/ English
Workload 1.0 ECTS-Points x 30 hours = 30 hours, **with the following allocation**				
Lectures 4 hours / 13.5%		**Practical Tasks/Group work** 8 hours / 26.5%		**Preparation/ follow up/ self-study** 18 hours / 60 %

6.1. Subtopic description

Code	Title of the sub-topic
Subtopic 4	Automation and Robotics in Livestock Production

6.2. Design of the sub-topic

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

Students have an understanding of the perspective areas of application of automation and robotics in livestock farming. They understand the functionality of automated systems and robotics in livestock production for e.g. feeding, milking, animal care and know the methodology for calculating economic efficiency in the case of the use of automated machines and robots in animal production.

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

- Capacities of automated systems application, the concept and scope of artificial intelligence and the Internet of things. Possibilities and limiting factors for the use of automation and robotics in agriculture. Evaluation of economic efficiency and sustainability when using automation and robotics
- Functioning of automated systems in cattle/dairy production
  - Automated milking systems
  - Automated feeding systems for cows, cattle and calves
  - Automated manure removal systems for cattle
  - Automated climate control systems for cattle
- Automation and robotization of pig production
  - Automated feeding systems for pigs
  - Automated manure removal systems for pigs
  - Automated climate control systems for pig farms
- Automation and robotization of poultry production
  - Robotization of poultry egg and meat production systems
  - Automated manure removal systems for poultry
  - Automated feeding systems for poultry
  - Automated climate control systems for poultry

Teaching/Learning forms
Lecture, excursions, exercises

Teaching/Learning methods
Lecture, presentation, discussion, case studies

Literature/ learning materials
Machines, equipment and their use in animal husbandry: a textbook for higher education degree holders / R. V. Sklyar, O. G. Sklyar, N. I. Boltyanska, D. O. Milko, B. V. Boltyanskyi . - K.: "Condor" Publishing House, 2019. - 608 p., illustrations.
Design of technological processes in animal husbandry / Revenko I.I., Zabolot'ko O.O., S.E. Potapova and others. - K.: CP Comprint LLC, 2018. 289 p.
Automation of technological processes of agricultural production. Ed. I. I. Martynenko. [Electronic resource]. – URL: http://buklib.net/books/35489/

Other
Farm visits, guest lecturers

6.3. Organisation of the sub-topic

ECTS-Points 1.0	**Semester week hours**	**Grouping/** No	**Reccommended study semester**	**Language** Ukrainian/ English
Workload 1.0 ECTS-Points x 30 hours = 30 hours, **with the following allocation**				
Lectures 4 hours / 13.5%		**Practical Tasks/Group work** 8 hours / 26.5%		**Preparation/ follow up/ self-study** 18 hours / 60 %

6.1. Subtopic description

Code	Title of the sub-topic
Subtopic 5	Management Information Systems in Livestock Farming

6.2. Design of the sub-topic

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

Students have a holistic view of information technology in the field of management information systems in modern livestock farming. They understand the functions of management information systems in practical agriculture and know Farm Management Information System software used in agricultural enterprises in livestock production and how to apply the software effectively.

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

- Principles and functions of Farm Management Information Systems in livestock production.
- Use of artificial intelligence for decision support systems and their application in practice
- Practical application of Farm Management Information Systems in animal production
- Software for digital farming in cattle/milk, pig and poultry production

Teaching/Learning forms
Lecture, excursions, exercises

Teaching/Learning methods
Lecture, presentation, discussion, case studies

Literature/ learning materials

Silveira, R. M. F., Façanha, D. A. E., McManus, C. M., Ferreira, J., & da Silva, I. J. O. (2023). Machine intelligence applied to sustainability: A systematic methodological proposal to identify sustainable animals. *Journal of Cleaner Production*, *420*, 138292. https://doi.org/10.1016/j.jclepro.2023.138292

Fote, F. N., Roukh, A., Mahmoudi, S., Mahmoudi, S. A., & Debauche, O. (2020). Toward a big data knowledge-base management system for precision livestock farming. Procedia computer science, 177, 136-142. https://doi.org/10.1016/j.procs.2020.10.021

Niloofar, P., Francis, D. P., Lazarova-Molnar, S., Vulpe, A., Vochin, M. C., Suciu, G., ... & Bartzanas, T. (2021). Data-driven decision support in livestock farming for improved animal health, welfare and greenhouse gas emissions: Overview and challenges. *Computers and Electronics in Agriculture*, *190*, 106406. https://doi.org/10.1016/j.compag.2021.106406

Kleen, J. L., & Guatteo, R. (2023). Precision Livestock Farming: What Does It Contain and What Are the Perspectives?. Animals : an open access journal from MDPI, 13(5), 779. https://doi.org/10.3390/ani13050779

Norton, T., Berckmans, D. (2023). Precision Livestock Farming: Developing Useful Tools for Livestock Farmers. In: Zhang, Q. (eds) Encyclopedia of Smart Agriculture Technologies. Springer, Cham. https://doi.org/10.1007/978-3-030-89123-7_27-1

Other
Farm visits, guest lecturers

6.3. Organisation of the sub-topic

ECTS-Points 1.0	**Semester week hours**	**Grouping/** No	**Reccommended study semester**	**Language** Ukrainian/ English
Workload 1.0 ECTS-Points x 30 hours = 30 hours, **with the following allocation**				
Lectures 4 hours / 13.5%		**Practical Tasks/Group work** 8 hours / 26.5%		**Preparation/ follow up/ self-study** 18 hours / 60 %