University of Zagreb Faculty of Agriculture
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Forage Conservation (296596)

Course coordinator

Prof. Marina Vranić, PhD

Course description

The module consists of five units: (i) introduction into forage conservation; (ii) preharvest and postharvest factors affecting forage conservation; (iii) forage conservation technology (drying and ensiling); (iv) storage and feeding of conserved forage and (v) forage quality assessment. The introduction into forage conservation gives insight into history, origin and aims of conserving forage for animal production. The preharvest and postharvest factors affecting forage conservation dealing with natural and cultivated crops characteristics and their selection for conservation. Forage conservation technology works out hay and silage production technology, additives, physical and chemical changes in forage conservation, looses of nutrients involved in forage conservation. Besides, it deals with fermentation in silos and micro-organisms' activity. Storage and feeding of conserved forage work out methods of storing conserved forage and utilization of dried and ensiled crops. Forage quality assessment covers the determination of the nutritive value of conserved forage by chemical, physical and biological methods.
This module should be taught by lecturing, laboratory practices, field sessions and seminars as appropriate.

ECTS: **3.00**

E-learning: **L1**

Teaching hours: 30
Lectures: 19
Practicum: 3
Seminar: 5
Field exercises: 3

Lecturer

- Prof. Krešimir Bošnjak, PhD

Grading

Sufficient (2): 61-69 %
Good (3): 70-79 %
Very good (4): 80-89 %
Excellent (5): >90%

Conditions for obtaining signature

Students are required to attend all learning and teaching sessions associated with the course, to prepare and present seminar work.

Type of course

- Undergraduate studies / BS Courses taught in English (Elective course, 2 semester, 1 year)

General competencies

Upon completion of the module students are able to determine the optimal phase of plant phenological phase for conservation, to create a forage production plan on the farm, to choose the appropriate technology for forage conservation and to understand the forage quality report.

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Types of instruction

- Lectures
  Lectures are mostly held at the experimental Grassland Research Station on Medvednica mount which is about 40km away from the Faculty.
- Laboratory practice/exercises
  Laboratory practice include an introduction to forage sampling and laboratory equipment used for the determination of forage basic chemical composition by wet chemistry or by NIR spectroscopy. Students become familiar with the basic chemical parameters determined in the lab and their influence on forage nutritive value. Student is asked to analyze a couple of forage samples by NR spectroscopy and to read the analytical report.
- Field work
  Field work include a tour to the experimental Grassland Research Station which enables students to detect certain forage types, to understand current grassland experiments, to see the field equipment and machinery used for forage conservation and feeding with en emphasis on big bale haylage production.
- Seminars
  Throughout the semester, the student is obligated to make the seminar and present it during lectures. The seminar covers 4 pages written in the World and 10-15 minutes of power point presentation.

Learning outcomes

Learning outcome	Evaluation methods
students will be able to describe forage conservation techniques	Class discussion, seminar, exam
students will be able explain the preharvest and postharvest plant factors affecting forage conservation (buffer capacity, sugar minimum, the advantages of forage drying over ensiling and vice versa, fermentation in silo, loss of nutrients at drying/ensilig)	Discussion, writing test
students will be able to identify the effect of forage conservation principles and procedures on forage quality	Discussion, writing test, oral exam
students will be able to sort the operation and buildings used in the forage conservation and storage	Class discussion, seminar
students will be able to choose the feeding method of conserved forage and to explain the effects of forage quality on animal health	Practical work, field trip, oral exam
students will be able to determine conserved forage quality according to chemical, physical and biological characteristics (concentration of DM, OM, CP, NDF, ADF, fermentation parameters)	Laboratory practise

Working methods

Teachers' obligations

Teachers are expected to keep records on the class attendence, to keep students informed on the planned activities, to explaine all the the topics involved in the class, to specify seminar topics on time, to discuss more topics on the students' interest, to prepare writing exams and to evaluate students work throught semester.

Students' obligations

The student should regularly attend classes, meet the obligations throught the semester and successfully pass seminar work, writing exams and the final exam.

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Methods of grading

Evaluation elements	Maximum points or Share in evaluation	Grade rating scale	Grade	Direct teaching hours	Total number of average student workload	ECTS
Seminar essay	50	up to 20 21-25 26-30 31-35 36-40	Insufficient (1) Sufficient (2) Good (3) Very good (4) Excellent (5)			0.5
Class attendance and participation	50	up to 20 21-25 26-30 31-35 36-40	Insufficient (1) Sufficient (2) Good (3) Very good (4) Excellent (5)			0.5
Major (hour) tests	100	up to 60 61-70 71-80 81-90 91-100	Insufficient (1) Sufficient (2) Good (3) Very good (4) Excellent (5)			1
Final exam	100	up to 60 61-70 71-80 81-90 91-100	Insufficient (1) Sufficient (2) Good (3) Very good (4) Excellent (5)			1
Total	300					3

Evaluation elements	Description	Deadline	Recoupment
oral examinations	the student should prove that he or she is able to recognize the context of the subject area. The oral exam takes place in front of one examiner. For every student the duration of the exam usually amounts to 30 minutes.	By the end of the semester.	If proven reason the recoupment is agreed with a class coordinator.

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Weekly class schedule

1. Introduction into forage conservation L - History, origins and the aim of forage conservation (hay production and silage making), current production of silage and hay, advantages of silage making over hay production and vice versa.
2. Plant factors affecting conservation of natural grassland L - Effect of harvesting on grassland botanical composition and its potential effect on conserved forage quality.
3. Crops characteristics and selection for conservation L - Factors affecting forage conservation (fertilization, plant growth stage at harvesting and its effect on composition and yield of nutrients, the height of cutting…)
4. Crops characteristics and selection for conservation L - Crops and their characteristics for conservation (grasses and legumes, cereals, root crops, other fodders).
5. Forage drying L - Hay production technology, the drying process, types of dry forages, physical and chemical changes involved in the drying process, use of additives, the looses involved in forage drying.
6. Forage ensiling, fermentation in the silo L, F - Silage technology , types of silage, phases of ensiling, fermentation process, micro-organisms activity, chemical changes in the silo.
7. Looses of nutrients involved in silage L, S - The looses involved in silage making; mechanical chemical (oxidation, respiration, fermentation..).Silo looses (effluent production, surface looses..), measurement of looses.
8. Mechanization in forage conservation L, F - Mechanization in forage conservation; field mechanization, mechanization for storing and feeding of conserved forage.
9. Additives in forage conservation L, S - Silage additives (stimulators of fermentation, inhibitors of fermentation, inhibitors of aerobic deteoriation, nutrients and absorbents) and their effect on silage quality.
10. Storage of conserved forage L, F - Methods of storing silage (stacks and clamps, the trench silo, pits and towers, vacuum silo, experimental and small silo). Methods of storing hay. Looses involved in storage of conserved forage.
11. Feeding conserved forage and animal health L, P - Utilization of dried and ensiled crops (cattle, horses, sheep..) and the effect on animal health (moulds, yeasts, clostridia, toxins, harmful constituents..).
12. Determination of conserved forage quality L, S - Determination of forage quality; sampling, chemical analysis (chemical composition), physical methods (impurities, colour, NIR spectroscopy..), biological methods (in vitro, in vivo, in sacco).
13. Hay and silage quality evaluation L, P - Physical and chemical methods of evaluating conserved forage; physical (stage of growth, colour, smell, composition – grass/legume contribution, weeds..), chemical (dry matter, organic matter, crude proteins, neutral detergent fibre, acid detergent fibre..)
14. Hay and silage quality evaluation L, P - Biological methods in conserved forage evaluation (intake, degradability, digestibility..).
15. Examination

Obligatory literature

1. Hopkins, A. (2000) Grass, its production and utilization. British Grassland Society, selected chapters.
2. Holmes, W. (1989) Grass, its Production and Utilisation, 2nd edn. Oxford, Blackwell Scientific Publications, selected chapters
3. Dwayne R. Buxton (2003) Silage Science and Technology, American Society of Agronomy, selected chapters.

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Recommended literature

1. McDonald, P.; A.R. Henderson; S.J.E. Heron (1991.) The Biochemistry of Silage, 2nd edition Marlow, Chalcombe Publications.
2. Cherney, J.H., Cherney, D.J.R. (1998.) Grass for dairy Cattle. CABI Publishing, selected chapters
3. Matsushima, J.K. (1979.) Feeding Beef Cattle. Berlin Heidelberg New York, selected chapters
4. Allen, D., B. Kilkenny (1980.) Planned Beef Production. Granada Publishing, selected chapters.
5. Givens, D.I., E. Owen, R.F.E. Axford, H.M. Omed (2000): Forage Evaluation in Ruminant Nutrition, CAB International, selected chapters.

Similar course at related universities

- Forage Production and Conservation, University of New Delhi
- Forage Science and Range Management, University of Florida

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