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Методичні вказівки до практичних занять для студентів
економічних спеціальностей

(для груп із поглибленим вивченням англійської мови)

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Укладачі: Г.П. Бондаренко

Рецензент: І.П. Чумаченко

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Навчальне видання

ТЕХНОЛОГІЯ ВИРОБНИЦТВА ПРОДУКЦІЇ ТВАРИННИЦТВА

методичні вказівки до практичних занять для студентів економічних спеціальностей (для груп із поглибленим вивченням англійської мови)

Відповідальний за випуск: Г.П.Бондаренко

Укладачі: БОНДАРЕНКО Геннадій Петрович,
кандидат сільськогосподарських наук, доцент

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Ukraine
National University of Life and Environmental
Sciences of Ukraine

Chair of Beef and Milk Production

Technology of Animal Products Production

The practical guide for laboratory classes for the students
of economical majors
(for groups with intensive English learning)

Kyiv 2015

Preface

Livestock production plays an important role in agricultural production of Ukraine, providing food for human and raw materials for manufacture. It also contributes considerably to food safety and economic progress of the country. That is why it is essential for the future managers to study the basics of animal science, that is, the complex store of knowledge relative to the breeding, feeding, care, and management of animals and marketing and processing of animals and their products.

This workbook has been designed to help students in studying the main principles of technology of animal products production and to gain better understanding of factors that influence the effectiveness and profitability of livestock production. The twenty lessons will guide you through the main topics related to such branches of animal production as cattle breeding, swine production, egg and broiler production, wool production and grading. Along with brief theoretical information on feeding, breeding, animal reproduction, products quality estimation, each lesson has a do-it-yourself division, where through simple calculations a student gets the possibility to try the theory in practice.

A special concern is given to economical aspects of livestock farming, estimation of the profitability of animal products production, emphasizing the factors influencing the success in livestock business.

We hope that this concise workbook will be interesting to students and stimulate them to further studies in technology of animal products production.

Lesson 1. Visual evaluation of farm animals

There are four main bases of selection: selection based on type and individuality, selection based on pedigree, selection based on production testing, selection based on progeny testing.

Selection based on type and individuality suggests studying and estimation of exterior through a visual evaluation.

Exterior – general appearance of an animal, its outer forms and body features, which determine type and individuality. The procedure of exterior evaluation is commonly called **judging**.

Good **judging procedure** consists of the following three separate steps:

- ✓ observing at a distance (6-9 m) and securing a panoramic view where several animals are involved ;
- ✓ using close inspection and viewing an animal from all directions: side view, rear view and front view;
- ✓ moving the animal in order to observe action.

The first step in preparation for judging consists in mastering the language that describes and locates the different parts of an animal.

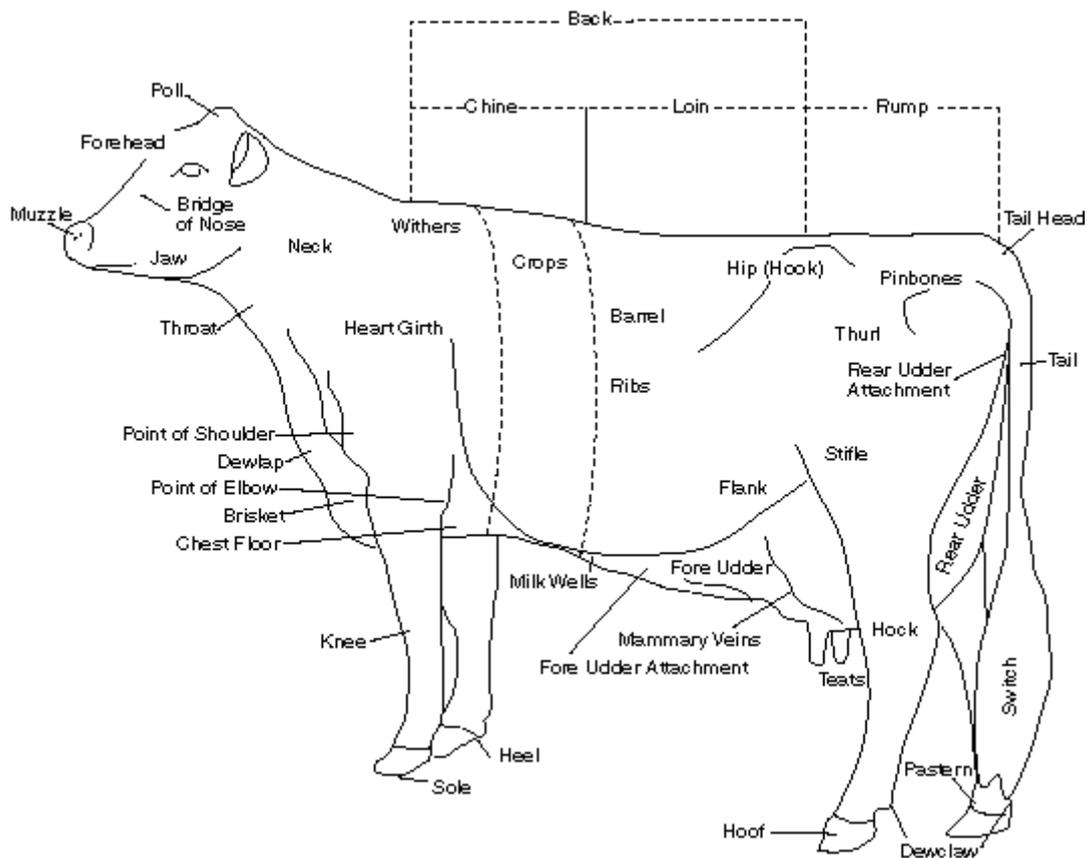


Fig. 1.1 Parts of a dairy cow

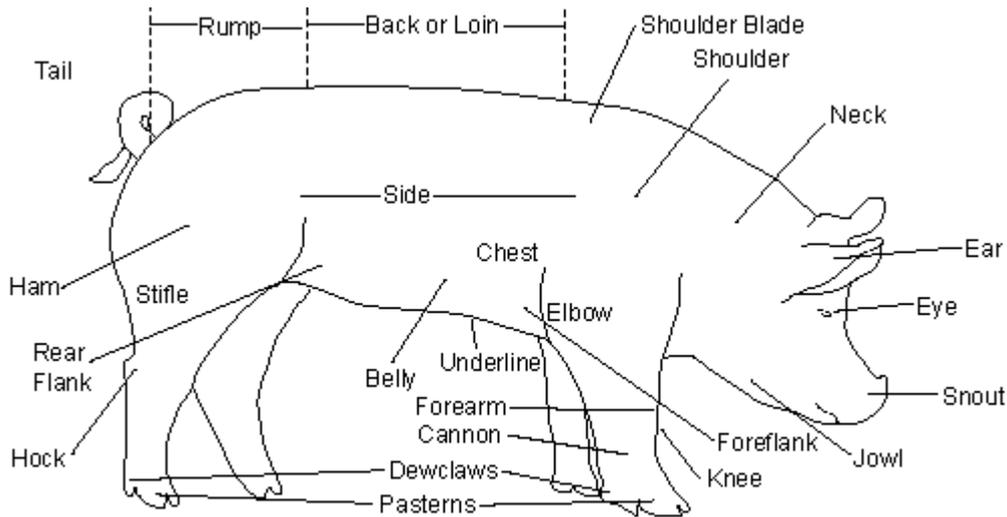


Fig. 1.2 Parts of a hog

Methods of studying the exterior:

1. Expert judging – visual appraisal of an animal, describing the parts of the body, pointing out the defects.
2. Scorecard judging – listing of the different parts of an animal, with a numerical value assigned to each part according to its relative importance. The modern American dairy cow scorecard gives 30 points to general appearance, 20 points to dairy character, 20 points to body capacity and 30 points to mammary system (see table 1.1).
3. Body measurements – allows to assess the general development of a certain part. Instruments: measuring stick, pair of compasses, measuring ribbon. The main body measurements: body length (slanting); body length (straight); height at withers; height at rump; heart girth; chest depth; udder circumference; metacarpus circumference; width at shoulders; width at hips; width at pin bones.
4. Conformation indexes – relation between certain measurements.
Some conformation indexes:
 - a) Leg index = $(\text{Height at withers} - \text{Chest depth}) \times 100\% / \text{Height at withers}$
 - b) Chest index = $\text{Width behind the shoulder blades} \times 100\% / \text{Chest depth}$
 - c) Compactiveness index = $\text{Heart girth} \times 100\% / \text{Body length (slanting)}$
 - d) Longevity index = $\text{Body length (slanting)} \times 100 / \text{Height at withers}$
5. Exterior profile – graphical representation of degree of deviation the measurements or indexes of an animal from a certain standard.
6. Photographing.

1.1 Extracts from the American Dairy Cow Scorecard

Dairy cow scorecard	Perfect score	Animal		
		No.1	No.2	Etc.
General appearance: Attractive individuality with femininity, vigour, harmonious blending of all parts and impressive style and carriage10 Head: clean-cut, proportionate to body Shoulder blades: set smoothly and tightly against the body Back: straight and strong; loin broad and nearly level10 Legs and feet: bones flat and strong, pasterns short and strong; forelegs medium in length, strait, wide apart; hind legs, nearly perpendicular from hock to pastern, from the side view, and straight from the rear view.....10	30			
Dairy character: evidence of milking ability, angularity, without weakness, freedom from coarseness.....20	20			
Body capacity: relatively large in proportion to size of animal, providing ample capacity, strength and vigour; barrel, strongly supported, long and deep; heart girth, large and deep.....20	20			
Mammary system: a strongly attached, well balanced, capacious udder of fine texture indicating heavy production and long period of usefulness Udder: symmetrical, moderately long, wide and deep, strongly attached, showing moderate cleavage between halves.....10 For udder: moderate length, uniform width from front to rear and strongly attached.....6 Rear udder: high, wide, slightly rounded and strongly attached.....7 Teats: uniform size, of medium length and diameter, cylindrical, squarely placed under each quarter5 Mammary veins: large, long, tortuous.....2	30			
Total score	100			

Do it yourself! Write down parts of the body of a cow and a hog in form of a table giving the proper Ukrainian equivalents. Note the differences in naming and in segregating the identical parts of different animals.

Lesson 2. Livestock identification methods

Individual Animal Identification is a means of identification that provides the capability to differentiate one animal from another. Animal identification system that uniquely identifies each animal will make it possible to: identify the origin of each animal; trace the path of each animal from location to location; trace each animal exposed to disease; eradicate or control an animal health threat.

The ability to track animal movements will aid in locating the source and spread of animal diseases, such as BSE and brucellosis. In other words, **traceability** is a deciding factor in providing food safety and bio-security.

European Union legal definition for traceability is EU General Food Law Regulation EC No. 178/2002: “The ability to trace and follow a food, feed, food-producing animal or substance intended to be or expected to be incorporated into a food or feed, through **all** stages of production, processing and distribution”.

Thus, individual animal identification contributes to improving the traceability of animal products in a whole food chain and in this way providing for steady market development.

All methods of identification could be subdivided in 2 large groups:

1. Visual methods of identification;
2. Electronic methods of identification.

Visual identification methods provide for application the visible mark on animal skin. Those marks could be following:

1. **Freeze brands/cryogenic branding:** an identification method that utilizes super-cooled branding irons to produce a hairless brand/scar for white or light coloured animals or a white hair brand for dark coloured animals;

2. **Hot brands:** an identification method that is a permanent, hair free scar in the shape of the iron used and applied to upper hip area;

3. **Tattoos:** marking by piercing the skin with instruments equipped with needle points which form letters or numbers. This operation is followed by rubbing inedible ink or paste into the freshly pierced area. After healing the tattoo is permanent;

4. **Paint Brands:** irons dipped in a quick drying paint and applied to hip area or ribs of animal. Offer high visibility but only temporary for locating animals in a pen for sale/shipment purposes;

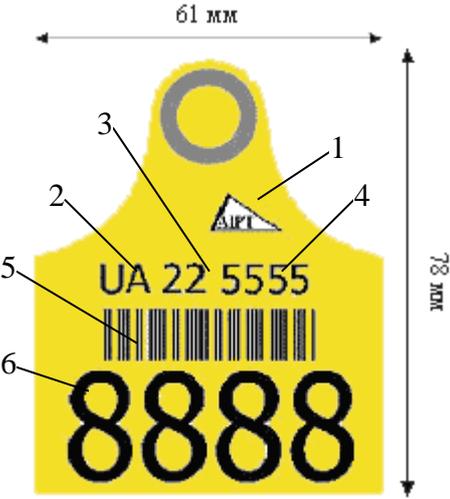
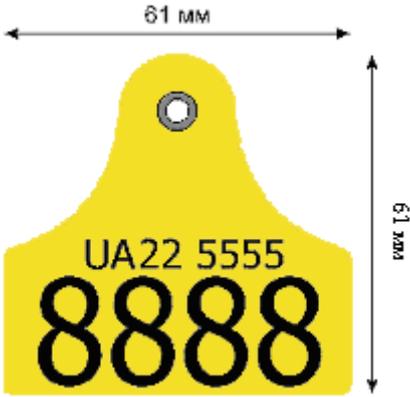
5. **Ear notching:** combination of round punctures and V-shaped indentations on ear edges. Each notch has its specific numerical meaning – combination of all notches reflects the animal individual number. Such marks are permanent, easily recognized but unattractive, most commonly used for swine.

6. **Plastic ear tags:** the most popular method of animal identification due to its economy, high flexibility and readability. Ear tagging is the basis for the **National Animal Identification and Registration System** created in 2003 (Regulation No 342 by 17 September 2003, amended by the Ministry of Agricultural Policy of Ukraine). The system for identification and registration of animals comprises the following elements: ear tags to identify animals individually; computerized databases; animal passports;

individual registers kept on each holding. The format for the *Animal Identification Number* is 12-character alphanumeric system; the meaning of each character is shown in the table below.

Animals Registry is a common automatic data base of cattle in Ukraine which accumulates information about identified animals, their transference, owners, farms and their sanitary state etc. Thanks to the informational and analytical base of the Registry a unique opportunity to keep under control epizootic situation in the country, receive operative quantitative and qualitative data about cattle and secure the market of animal husbandry products appears. The Registry also records data about temporary (exhibitions, markets, remote pastures etc.) and final transference (locations) of animals: wreck, slaughter, utilization etc. Further it will be formed similar registries for sheep, goats, swine, and horses.

2.1 Animal Identification Number Format

Front side	Rear side
	
<p>1. Logo of the National Agency of Animal Identification and Registration</p>	
<p>2. Positions 1, 2: Internationally recognized code of the country , where the animal is registered (UA = Ukraine)</p>	
<p>3. Positions 3, 4: Numeric code of the oblast , where the animal is registered</p>	
<p>4. Positions 5 – 8: The first for digits of the animal identification number</p>	
<p>5. Bar-code</p>	
<p>6. Positions 9 – 12: The last for digits of the animal identification number (work number of the animal)</p>	

Animal electronic identification technologies currently being developed will identify and trace each individual animal from birth to slaughter more efficiently and accurately than traditional identifiers. Electronic identification technology currently being supported for use in

livestock identification is a transponder-based technology. The word transponder comes from “transmitter” and “responder”. All transponders contain a microchip and an antenna. Animal electronic identification technology uses passive Radio Frequency Identification (RFID) because it is cost effective and offers the characteristics desired for animal identification. RFID technology does not suffer from signal absorption by tissue or moisture, and it can be packaged differently without affecting performance.

Principles of RFID Transponder Technology:

- ✓ Packaged in plastic ear tags, in a bolus, or injected under the skin.
- ✓ Each microchip has a unique identification number.
- ✓ The transponder is activated by the magnetic field of the antenna and sends a unique identification code to the reader.
- ✓ The code can be displayed and sent to a data processing unit such as a process control computer.

RFID Transponder Types

- ✓ Electronic ear tag - a microchip and a coiled copper antenna is encapsulated in a small plastic ear tag.
- ✓ Bolus - a microchip and antenna are placed inside a small glass ampoule held in a high specific gravity ceramic capsule (bolus) and inserted orally into the ruminant's fore-stomachs, usually the reticulum.
- ✓ Injectable transponder - a microchip and antenna are held in a small glass ampoule and injected under the skin.

Benefits of RFID Technology

- ✓ Potential to provide a more reliable and effective livestock identification system than traditional identification systems.
- ✓ Supports computerized and automated recording in order to manage a large volume of livestock in a cost effective and efficient manner, especially for purposes of animal disease control, surveillance, and prevention.
- ✓ Signal absorption is not adversely affected by adverse environments such as moisture or tissue due to the low frequency radio waves.
- ✓ Allows for suitable read distances for automated reading and recording in abattoirs, and sale yards.

Do it yourself! List the methods of livestock identification and estimate advantages and disadvantages of each method in terms of visibility, stability, and labor economy. Present your writings in form of the table:

Identification method	Advantages	Disadvantages

Lesson 3. Classes of feeds, measuring and expressing nutritious value of feedstuffs

Feeds contain nutrients that are used to meet the requirements of animals.

Nutrients are chemical substances that are necessary for the maintenance, growth, production, reproduction and health of the animal. There are five main categories of nutrients: water; energy (carbohydrates: sugars, starch, “crude” fibre; lipids); protein (nitrogenous compounds or „crude“ protein); minerals; vitamins.

Feeds may be classified by various criteria - by origin, by nutritious value etc. According to its origin, all feeds can be subdivided into such categories: feeds of plant origin; feeds of animal origin, mineral supplements, biologically active substances, food by-products.

According to the energy and fibre content, feeds are divided into forages and concentrates.

1. Forages. In general, forages are the vegetative parts of grasses or legume plants containing a high proportion of fibre (more than 19% of crude fibre in the dry matter) and are low in energy. The general characteristics of forages are as follows:

a) **Bulky:** Bulkiness puts limits on how much an animal can eat.

b) **High fibre and low energy:** In general, the higher the fibre in forage, the lower the energy content of the forage.

c) **Variable in protein:** Depending on the stage of maturity, legumes may contain 15 to 23% crude protein; grasses typically contain 8 to 18% crude protein (depending on the level of nitrogen fertilization), and crop residues may have only 3 to 4% crude protein (straw). From a nutritional standpoint, forages may range from very good feeds (lush young grass, legumes at a vegetative stage of maturity) to very poor feeds (straw, browse).

Further, according to the moisture content, forages may be subdivided into:

a) **Roughages** (dry feeds, coarse feeds) – hay (grass hay and legume hay), straw, chaff, crop residues, - contain less than 20% of water;

b) **Succulents** – green fodder, pasture, silage, haylage, root crops and tubers, beet tops etc., - contain more than 40% of water.

2. Concentrates – grains (cereals and beans) and their by-products, products from animal and plant processing and from industrial manufacturing. Usually, concentrates have the following characteristics:

a) They are **low in fibre and high in energy** (1kg of dry matter contains at least 7,3 MJ of metabolizable energy and less than 19% fibre).

b) They can be either low or high in protein. Cereal grains contain <12% crude protein, but oilseed meals (soybean, cotton, peanut), referred to as *protein feeds*, can contain > 50% crude protein.

c) They have a *high palatability* and are usually *eaten rapidly*. As opposed to forage, concentrates are feed that usually have a low volume per unit of weight (high specific gravity).

To estimate the energy value of feedstuffs, several systems are adopted at present. Among them are:

1. Calories system. Calories or mega joules are used to express the energy value of feedstuffs. One calorie is the amount of heat required to raise the temperature of 1g of water by 1°C. To measure this heat energy, an instrument known as the bomb calorimeter is used, in which the feed to be tested is placed and burned in the presence of oxygen. Along with direct method, the energy value of feedstuff can be measured indirectly, using the special equations, that is, regression models. In modern practices mega joules (international units) are beginning to be most often used instead of the calories: 1 cal = 4,184 joules.

The following terms are used to express the energy value of feeds (see figure 3.1):

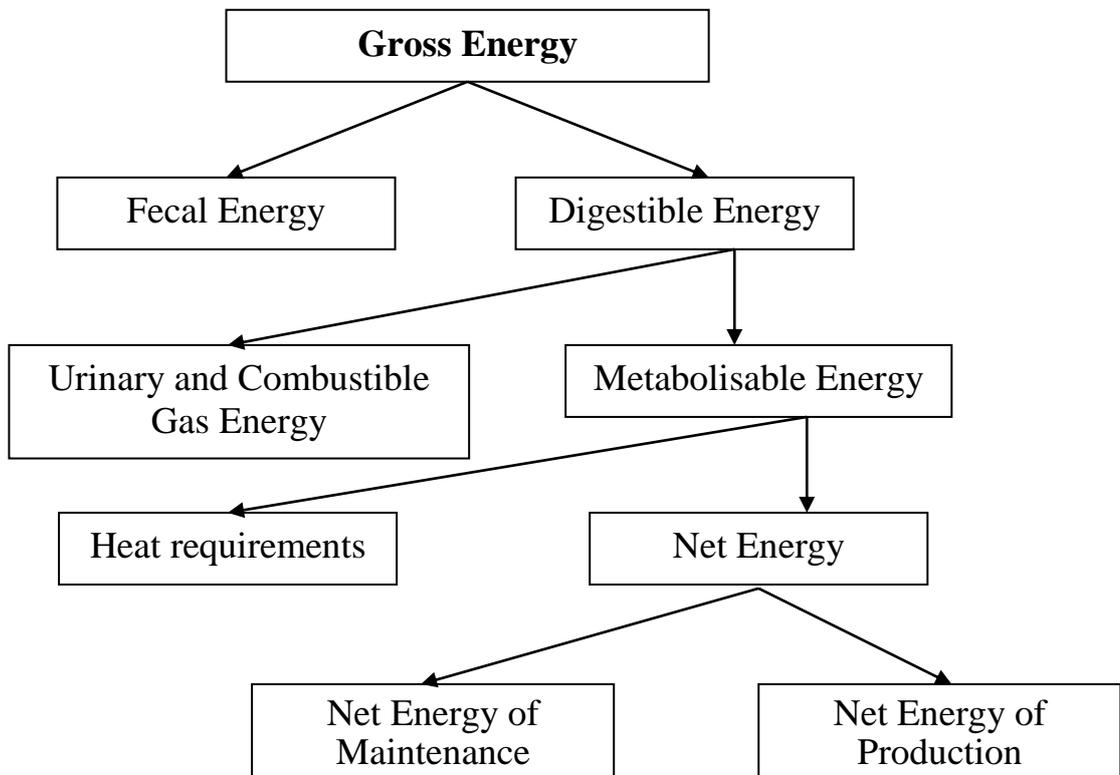


Fig. 3.1 Utilization of energy

1. Gross energy (GE) – represents the total energy in a feedstuff.
2. Digestible energy (DE) – is that portion of the GE in a feed that is not excreted in the feces.
3. Metabolizable energy (ME) – represents that portion of the GE that is not lost in the feces, urine and gas. It more accurately describes the useful energy in the feed, but not take into account the energy lost as heat.
4. Net Energy (NE) – represents the energy fraction in a feed that is left after the fecal, urinary, gas and heat losses. NE is a most precise measure of the real value of the feed than other energy values. But it is much more difficult to determine.

Two systems of net energy evaluation are presently being used. Lofgreen and Garrett (1968) developed a system whereby the net energy requirements are listed as dictated by physiological functions – for example, net energy of maintenance (NE_m) and net energy for gain (NE_g). Also, Moe and Flatt (1969) developed a net energy system that compares the physiological function to that of lactation through the use of regression analysis. This value, $NE_{lactation}$, is applicable for all physiological functions.

2. Total digestible nutrient system (TDN) – is the sum of the digestible protein, fibre, nitrogen-free extract, and fat multiplied by 2,25. It has been most extensively used measure for energy in the United States and Canada.

3. Oat Feed Unit (OFU) system (was created and widely adopted in the former USSR countries) – feeding value of 1 kg average quality oat, which, fed to a mature ox over a maintenance ration, results in deposit of 150 g fat. In spite of continuous expansion of ME system, this system is still in use throughout the Ukraine for feeds energy evaluation and rations formulation. All feeds are compared by oat equivalent basis (oat feed units, OFU). For example, feeding value of 1 kg barley is 1,15 kg OFU, 1 kg yellow corn – 1,33 kg OFU etc.

The main *advantage* of the OFU system is that it has been used for a very long time and many people are acquainted with it. The main *disadvantages* of the OFU system are: a) it is an empirical method based upon chemical determinations that are not related to actual metabolism of the animal; b) it is expressed in weight (kg), whereas energy is expressed in calories or joules; c) it takes into consideration only digestible losses; it does not take into account other important losses, such as losses in the urine, gases, and increased heat production.

Because of these limitations, the OFU system is gradually being replaced by other energy evaluation systems, particularly ME and NE system. However, due to voluminous OFU data on many feeds and long-standing tradition, it will continue to be used by many people for a long

time to come.

Do it yourself! Calculate energy, protein and fiber content per 1 kg of dry matter of feeds listed in Appendix 1 and subdivide them into forages and concentrates according to the following pattern:

3.1 Nutrient concentrations in feeds

Forages				Concentrates			
Feeds	Content (DM-basis)			Feeds	Content (DM-basis)		
	ME, MJ	CP, %	CF,%		ME, MJ	CP, %	CF, %
<i>Roughages</i>				<i>Protein concentrates</i>			
Wheat straw	5,63	0,60	43,0				
....
<i>Succulents</i>				<i>Energy concentrates</i>			
				Barley grain	12,4	10,0	5,8
....

Note, that forages usually contain more than 19% CF in DM and less than 7,3 MJ ME while the protein content is varying from 3 to 20%. Concentrates usually contain less than 19% CF in DM and more than 7,3 MJ ME with crude protein varying from 7 to 65%.

Lesson 4. Principles of computation and balancing the rations

Feeding standards – are tables showing the amount of one or more nutrients needed by different species of animals for different purposes, such as growth, fattening and lactation. They serve as guides in balancing rations and feeding practices. Most feeding standards are expressed in 1) quantities of nutrients required per day; 2) percent of the ration (used when animals are fed free choice – ad libitum). Feeding standards for various kinds of livestock will be studied in corresponding animal feeding chapters.

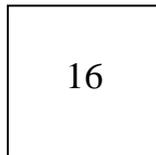
Balanced ration – is a ration, which provides an animal the proper proportions and amounts of all required nutrients.

In computing rations, more than simple arithmetic should be considered. Compounding rations is both an art and a science. To compute a ration, a special computer programs have been devised which utilize the methods of linear programming. But for the study purposes, let's look upon a simple, direct and easy way which allows figuring proportions between tow ingredients – **the square method**. In balancing ration by the square methods, it is recognized that one specific nutrient alone receives major consideration. Correctly speaking, therefore, it is a method of balancing one nutrient requirement, with no consideration given to the other nutritive requirements.

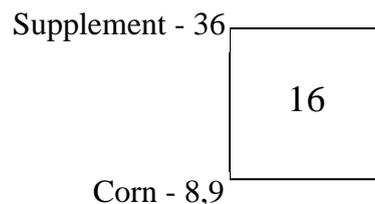
Example. A swine producer has 20 kg pig to which it is desired to feed a 16% protein ration. Corn containing 8,9% protein is on hand. A 36% protein supplement, which is reinforced with minerals and vitamins, can be bought. What percent of the ration should consist of corn and of the 36% protein supplement?

Decision:

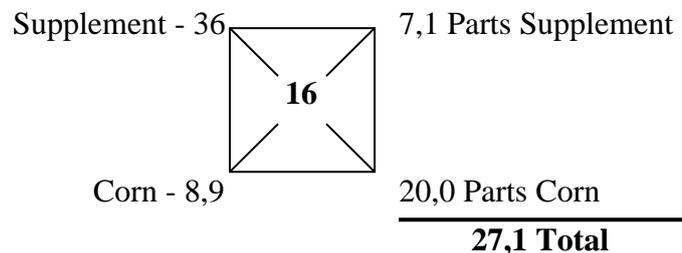
Step 1. Draw a square and place the number 16 (desired protein level) in the centre:



Step 2. At the upper left-hand corner of the square, write protein supplement and its protein content (36), at the lower left-hand corner write corn and its protein content (8,9):



Step 3. Subtract diagonally across the square (the smaller number from the large number), and record the difference at the corners of the right-hand side. The number at the upper right-hand corner gives the parts of concentrate by weight, and the number at the lower right-hand corner gives the parts of corn by weight to make a ration with 16% protein:



Step 4. To determine what percent of the ration would be corn, divide the parts of corn by the total parts and multiply by 100, and so with the percent of protein supplement: $(20/27,1)*100%=73,8%$ corn; $(7,1/27,1)*100%=26,2%$ protein supplement.

The square method is mostly used in calculating the structure of

combined fodder in swine and poultry production. As to the cattle feeding where in most cases feeds are fed separately (roughages, succulents and concentrates), the **trial and error method** is widely practiced.

Example. Let's assume that a dairy producer has a 600 kg cow producing 30kg of milk testing 3,6% fat. The producer is feeding 6 kg of alfalfa hay and 20 kg of corn silage per day. Corn, oats and soybean meal are available. What concentrate mix should the producer use to meet the needs of this lactating cow, from the standpoint of energy (net energy of lactation, NEL) and protein? Which mineral supplements should be bought to cover the requirements of cow in macro minerals (Ca and P)?

The available feeds have approximately the following composition:

4.1 Feed composition table

Feeds	Feed composition (per 1 kg)						
	Dry matter (DM), g	Oat feed units (OFU), kg	NEL, MJ	Crude protein (CP), g	Crude fiber (CF), g	Ca, g	P, g
Alfalfa hay	860	0,44	4,16	145,0	253,0	16,0	2,1
Corn silage	350	0,30	2,31	30,0	68,0	0,75	0,55
Corn	870	1,33	7,32	94,0	38,0	0,30	2,80
Oats	870	1,00	6,16	108,0	101,0	1,00	3,00
Soybean meal	870	1,21	7,51	440,0	62,0	2,70	6,10

Step 1. The daily energy, protein and macro elements requirements of this cow, that is, feeding standards (600 kg body weight, 30 kg of milk testing 3,6% fat) are: 21,0 kg OFU; 126,3 MJ NEL ; 2989g CP; 3780g CF; 129,5g Ca; 80g P.

Step 2. The forage (6 kg alfalfa hay, 20 kg corn silage) is supplying the following amount of nutrients:

4.2 Nutrients from forage

Feeds	Nutrients supply						
	DM, kg	OFU, kg	NEL, MJ	CP, g	CF, g	Ca, g	P, g
Alfalfa hay	5,16	2,64	24,96	870,0	1518,0	80,0	12,6
Corn silage	7,0	6,0	46,20	600,0	1360,0	15,0	11,0
Total from forage	12,16	8,64	71,16	1470	2878	95,0	23,6

Step 3. Remainder, to be supplied by concentrate mixture:

4.4 Nutrients from the concentrate mixture

Nutrient demands	Nutrients supply						
	DM, kg	OFU, kg	NEL, MJ	CP, g	CF, g	Ca, g	P, g
Feeding standard	20,00	21,0	126,3	2989	3780	129,5	80
Forage supply	12,16	8,64	71,16	1470	2878	95,0	23,6
Remainder	7,84	12,36	55,14	1519	902	34,5	56,4

c) Percent of oats: $\frac{3,2}{8,0} \cdot 100\% = 40,0\%$.

Calculate the protein content in this concentrate mixture:
 $44\% \times 0,262 + 9,4\% \times 0,338 + 10,8\% \times 0,40 = 19,0\%$.

Step 9. Sum up the nutrients in the ration and check the Ca and P supply:

4.5 Nutrients summary without mineral supplements

Feeds	Amount, kg	Nutrients supply						
		Dry matter, kg	OFU, kg	NEL, MJ	CP, g	CF, g	Ca, g	P, g
<i>Feeding standard</i>		20	21,0	126,3	2989	3780	129,5	80,0
Alfalfa hay	6,0	5,16	2,6	24,96	870,0	1518,0	80,0	12,60
Corn silage	20,0	7,00	6,0	46,20	600,0	1360,0	15,0	11,00
Soybean meal	2,1	1,83	2,5	15,77	924,0	130,2	5,67	12,81
Corn	2,7	2,35	3,6	19,76	253,8	102,6	0,81	7,56
Oats	3,2	2,78	3,2	19,71	345,6	323,2	3,20	9,60
Total		19,12	17,9	126,4	2993,4	3434	104,7	53,57
<i>Deviation from the norm, ±</i>		-0,88	-3,1	+0,1	+4,4	-346	-25	-26,43

Step 10. Conclusion: The ration is pretty well balanced on energy and protein regardless of deficiency in oat feed units (this is an example of how the abstract OFU concept doesn't match the modern approaches to energy feed value estimation). At the same time a strong calcium-phosphorus deficiency is clearly evident. And this requires proper supplementation. Dicalcium phosphate may be used as a source of calcium and phosphorus. This mineral contains 230 g Ca and 170 g P per 1 kg (see Appendix 2).

Step 11. Calculate the amount of dicalcium phosphate needed to meet calcium-phosphorus demand:

A 26,43 g phosphorus deficiency could be covered with 0,155 kg (26,43/170) of dicalcium phosphate. This also provides for 35,65 (0,155 x 230)g Ca, thus covering Ca demand.

Step 12. Considering the macro elements demand, such important nutrient as salt should be also taken into account. As will be shown later, to meet Na and Cl demand, it is recommended to use 5-7 g of salt per 100 kg live weight and 3 g per 1 kg milk. Thus the cow weighing 600 kg and producing 30 kg milk should receive about 120g of salt ((5g x 6)+(3g x 30)) daily.

Step 13. Include the mineral additives and make the final check of the ration:

**4.6 Ration of a cow weighing 600 kg
and yielding daily 30 kg milk testing 3,6% fat**

Feeds	Amount, kg	Nutrients supply						
		Dry matter, kg	OFU, kg	NEL, MJ	CP, g	CF, g	Ca, g	P, g
Feeding standard		20	21,0	126,3	2989	3780	129,5	80,0
Alfalfa hay	6,0	5,16	2,6	24,96	870,0	1518,0	80,0	12,60
Corn silage	20,0	7,00	4,0	46,20	600,0	1360,0	15,0	11,00
Soybean meal	2,1	1,83	2,5	15,77	924,0	130,2	5,67	12,81
Corn	2,7	2,35	3,6	19,76	253,8	102,6	0,81	7,56
Oats	3,2	2,78	3,2	19,71	345,6	323,2	3,20	9,60
Dicalcium.	0,155	0,150	-	-	-	-	35,65	26,43
Salt	0,120	0,116	-	-	-	-	-	-
Total		19,39	17,9	126,4	2993,4	3434	140,4	80,0
Deviation from the norm, ±		-0,61	-3,1	+0,1	+4,4	-346	+10,9	-

It should be noted that it is not only minerals supply, but their proper relationship in the ration, that is important. The proper Ca:P relationship for dairy cattle lays within a limit of 1,5-2:1. As could be seen from the ration above, the Ca:P ration makes up 1,76:1, thus not exceeding recommended level.

As to the other indices estimating feeding value of the ration, such parameters as energy, protein and fibre content per 1 kg of dry matter are playing an important role. In this ration we have 6,52 MJ NEL/kg DM (126,4/19,39), 15,4% CP (2993,4g x 100% / 19390g) and 17,7% CF (3434g x 100% / 19390g) which fits well the feeding standards.

Computer methods.

The most common technique for computer formulation of ration is the linear programming (LP) technique. At times this is referred to as “least cost” ration formulation. This designation results from the fact that most LP techniques for ration formulation have as their objective minimization of cost. A few LP programs are in use that solve for maximization of income over feed costs. Regardless, the livestock producer and nutritionist should always keep in mind that maximizing net profit is the only objective of most ration formulations.

Briefly described, the LP program is a mathematical technique in which a large number of simultaneous equations are solved in such a way

as to meet the minimum and maximum levels of nutrients and levels of feedstuffs specified by the user at the lowest possible cost.

Several computer programs for rations formulation are now in the market, the most sophisticated of them are Futter-2003 (Germany), Winmix (Belgium), Korm-Optima (Russia) and others.

Do it yourself! A swine producer has ____ kg pig to which it is desired to feed a ____ % protein ration. Such grains are available:

1. _____ containing ____% protein;
2. _____ containing ____% protein;

A ____ % protein supplement, which is reinforced with minerals and vitamins, can be bought. What percent of the ration should constitute grains and what ____ % protein supplement?

Do it yourself! A dairy producer has a ____ kg cow producing ____kg of milk testing ____ % fat. The main part of the ration (roughages) consists of:

1. _____ kg _____;
2. _____ kg _____;
3. _____ kg _____;
4. _____ kg _____;

Such concentrates are available: _____, _____, _____.

Calculate the concentrate mix and balance the ration to meet the nutritive needs of this lactating cow from the standpoint of energy (NEL), protein and macro elements.

Lesson 5. Growth recording and estimation of growth intensity

Weight, linear, and volume methods are used in the practice of animal breeding for the purpose of growth estimation. Frequency of weighing is dependent on kind and age of animal. It is usually performed in the morning before feeding and drinking. The growth intensity is expressed by absolute and relative values.

Do it yourself! Calculate the absolute live weight gain, average daily gain and relative gain of two groups of calves reared on different feeding levels. Draw the graphs of live weight changes, average daily gain and relative live weight gain (see Figures 5.1 - 5.3).

Absolute live weight gain is calculated according to the formula:

$$A = W_t - W_o,$$

where: W_o – live weight at the beginning of the period, kg;

W_t – live weight at the end of the period, kg .

Average daily gain is calculated by the formula:

$$D_a = \frac{W_t - W_o}{t},$$

where: D_a – average daily gain, g;

W_o – live weight at the beginning of the period, kg;

W_t – live weight at the end of the period, kg;

t – period between two weighings, days.

5.1 Growth of calves under the different feeding levels

Age, months	Group 1 (high-level feeding)				Group 2 (moderate level feeding)			
	Live weight, kg	Live weight gain			Live weight, kg	Live weight gain		
		absolute, kg	average daily, g	relative, %		absolute, kg	average daily, g	relative, %
At birth								
1								
2								
3								
4								
5								
6								

Relative gain (growth energy) is calculated by the formula:

$$E = \frac{W_t - W_o}{0,5(W_t + W_o)} \times 100\%$$

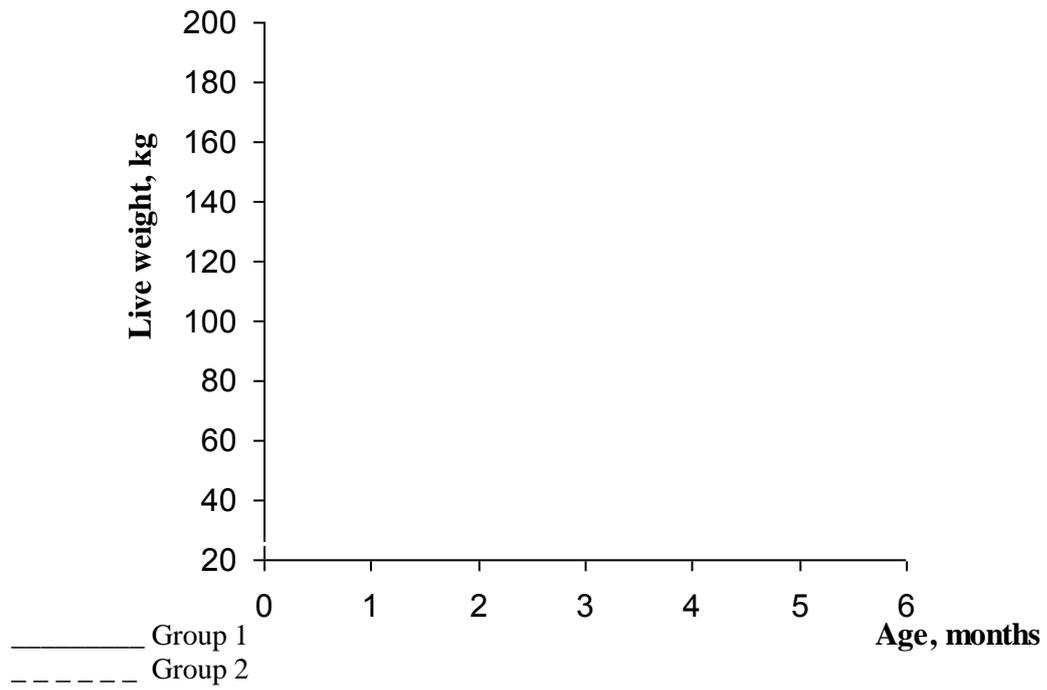


Fig. 5.1 Graph of live weight changes

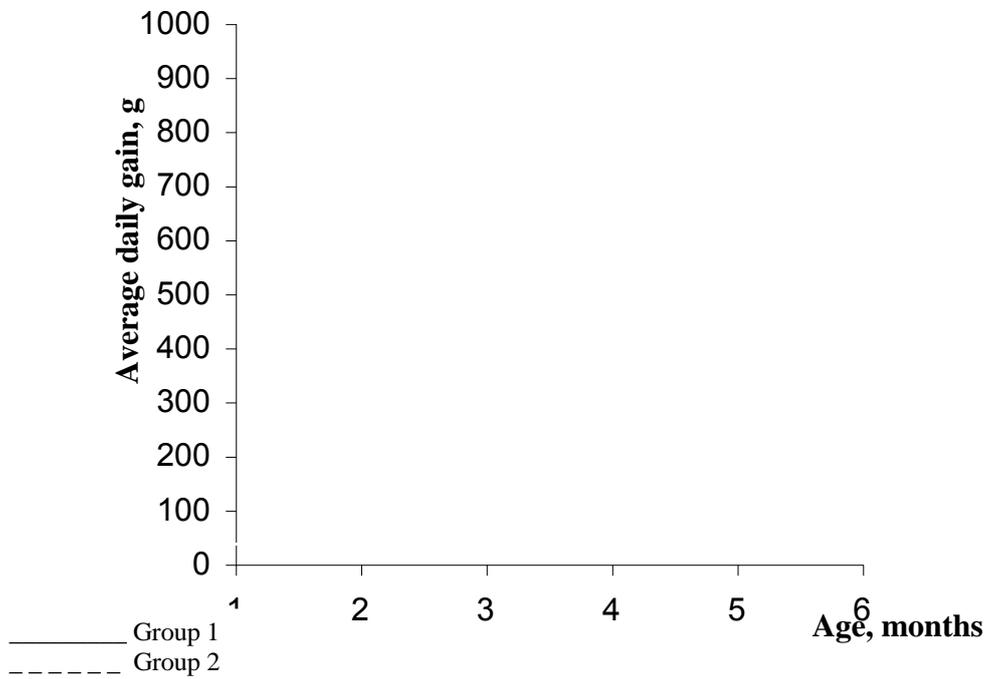


Fig. 5.2 Graph of average daily gains

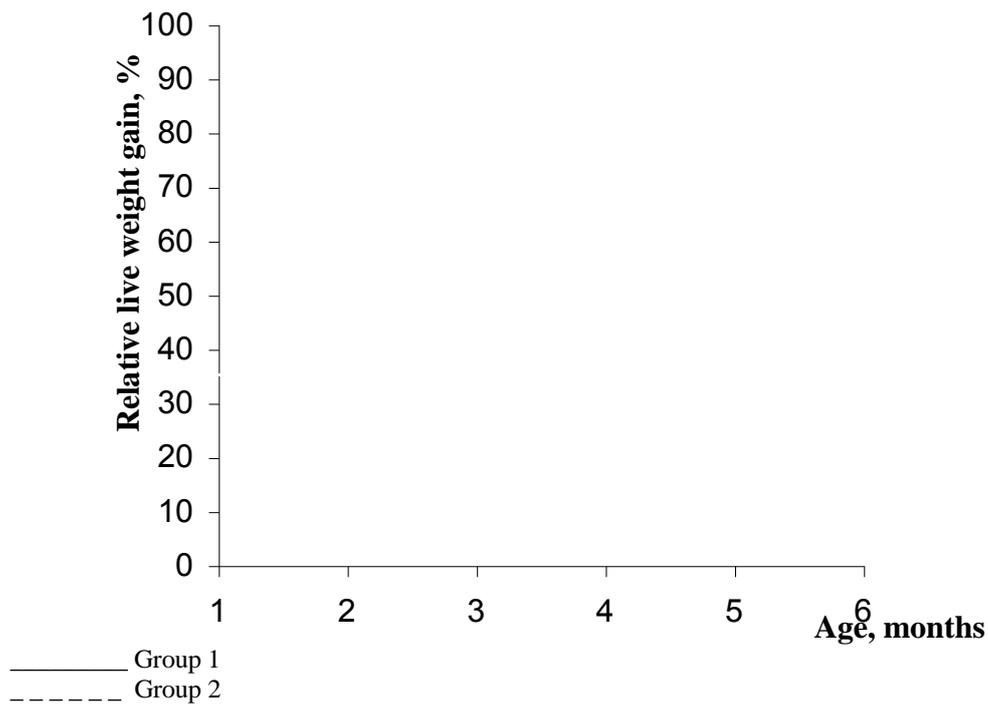


Fig. 5.3 Graph of relative weight gains

Lesson 6. Heard reproduction. Estimating reproductive efficiency in a dairy herd

Efficiency of reproduction is one of the most critical aspects of a profitable herd. Economic losses resulting from delayed reproduction have multiple facets:

- The lifetime milk production of the cows is reduced because peak milk production does not occur as often and the dry periods are extended;
- The number of calves born per year decreases, giving fewer opportunities to cull cows with low milk production, and slowing the possible gain in the genetic value of a herd;
- The direct costs for treatment of reproductive disorders, breeding and veterinary fees are increased.

In order to maximize productive life, a cow must be bred within 80 to 90 days after calving. This will enable her to produce a new calf every 12,5 to 12,8 months. Longer calving intervals have detrimental effects on lifetime milk production. Whether a producer uses artificial insemination or natural service, heat detection is a critical component of good reproductive management on the farm. In either case, recording of cows in heat and dates of services is necessary to predict future heat or calving dates and to

manage the cows accordingly.

Heat is a period of acceptance for mating (sexual receptivity) that normally occurs in non-pregnant, pubescent heifers and non-pregnant cows. This period of receptivity may last from six to 30 hours and occurs every 21 days on the average. However, the interval between two heats may vary normally from 18 to 24 days.

Detection of heat calls for acute observation. Most cows have a pattern of behaviour that changes gradually from the beginning to the end of a heat. The best indicator that a cow is in heat is when she stands and allows herself to be mounted by herdmates or a bull.

Artificial insemination or natural service lead to a pregnancy only if the spermatozoa are "at the right place at the right time." The egg is released from the ovary about 10 to 14 hours after the end of heat and can only survive unfertilized for six to 12 hours. In contrast, the spermatozoa may live up to 24 hours in the reproductive tract of a cow. A common recommendation for the best timing of artificial insemination is the "*morning-evening*" rule: cows observed in heat in the morning are inseminated the same evening and cows observed in heat in the afternoon are inseminated the next morning. In the case of natural service, the cow and the bull may be allowed to mate starting a few hours after the cow accepts mounting until the cow refuses to be mounted.

Case Study.

A dairy producer has a herd of 20 cows.

Reproductive data has been recorded during the year and included: dates of calving, dates of inseminations, pregnancy checks (see the table below).

Analyze reproductive performance of a dairy herd by the following indices:

- Average days open to first AI
- Average days open
- Number of services per conception
- First service conception rate
- Number of cows that conceived with less than 3 services
- Cows open more than 120 days
- Calving interval

Ind. Cow Nu.	Date of calving	Dates of Artificial Inseminations				Preg-nancy check	Date of calving (predict.)	Calculated intervals		
		First	Second	Third	Fourth			to 1 st AI	Open days	Calving interval
0001	01.01.2012	20.02.2012	14.03.2012	4.04.2012	-	Pregnant				
0002	05.01.2012	17.02.2012	11.03.2012	-	-	Pregnant				
0003	12.01.2012	23.02.2012	16.03.2012	6.04.2012	27.04.2012	Pregnant				
0004	16.01.2012	15.03.2012	-	-	-	Pregnant				
0005	05.02.2012	10.04.2012	2.05.2012	24.05.2012	-	Pregnant				
0006	08.02.2012	5.04.2012	27.04.2012	18.05.2012	9.06.2012	Pregnant				
0007	15.02.2012	18.04.2012	10.05.2012	-	-	Pregnant				
0008	03.03.2012	1.05.2012	23.05.2012	14.06.2012	6.07.2012	Pregnant				
0009	08.03.2012	6.05.2012	28.05.2012	17.06.2012	9.07.2012	Pregnant				
00010	08.03.2012	8.05.2012	30.05.2012	22.06.2012	-	Pregnant				
00011	15.03.2012	30.05.2012	-	-	-	Pregnant				
00012	22.03.2012	2.05.2012	23.05.2012	-	-	Pregnant				
00013	01.04.2012	15.05.2012	03.06.2012	24.06.2012	-	Pregnant				
00014	12.04.2012	28.05.2012	18.06.2012	-	-	Pregnant				
00015	15.04.2012	25.05.2012	15.06.2012	6.07.2012	-	Pregnant				
00016	22.04.2012	2.06.2012	23.06.2012	14.07.2012	-	Pregnant				
00017	01.05.2012	5.07.2012	26.07.2012	16.08.2012	6.09.2012	Pregnant				
00018	10.05.2012	4.07.2012	25.07.2012	-	-	Pregnant				
00019	14.05.2012	10.07.2012	-	-	-	Pregnant				
00020	20.05.2012	1.07.2012	22.07.2012	-	-	Pregnant				
Total	-	-	-	-	-	-	-			
Average	-	-	-	-	-	-	-			

Lesson 7. Cattle feeding. Making the ration for dairy cow according to physiological stage and performance level

The critical steps in developing a sound feeding program for dairy cows include the following:

Knowledge of the cow:

- ✓ Number of calving
- ✓ Body weight
- ✓ Milk production
- ✓ Stage of lactation

Knowledge of the feeds:

- ✓ Forage quality
- ✓ Crude protein in the concentrate mix
- ✓ Cost of the concentrate mix

Depending on these factors, the amount of concentrate to feed will range from 0 to 15 kg/day and the crude protein of the concentrate mix will range from 12 to 23%. The proper crude protein in the concentrate mix depends primarily on the stage of lactation of the cow and the quality of the forage.

From a practical aspect, to balance rations the following three questions must be answered.

1) What are the amounts of forage and concentrate to feed so that the cow can ingest the required amount of energy?

Forage is usually fed without restriction, and the amount of concentrate required in the diet depends on different factors:

- ✓ **Forage quality.** The energy content of mature forage is lower than the energy content of vegetative (immature) forage. Thus, more concentrates will be required in rations based on mature forages.
- ✓ **Energy needs of the cow.** The energy demand of the cow increases with increases in milk production. The amount of concentrate required in the ration is higher for a high-producing cow than a low producing cow. A dry cow should eat a ration of about 90 to 100% forage (0 to 10% concentrate), but a high-producing cow in early lactation will need a ration containing not less than 40 to 45% forage (55 to 60% concentrate).

2) What protein concentration in the concentrate mix should there be in order to provide the required amount of protein?

The crude protein needed in the concentrate mix depends on the type of forage in the ration. Forage with high crude protein content such as legumes, can be combined with a concentrate mix of low protein content. On the other hand, a low crude protein grass must be combined with a high crude protein concentrate mix to obtain a balanced diet.

3) What type of mineral supplement should be used and how much should be fed?

Salt (NaCl) and a calcium-phosphorus mineral can be offered free-choice. However, it is best to adjust the kind and amount of minerals in the ration to the animal's need. The amount of mineral to add to the ration depends on the following factors:

- ✓ ***Type of forage in the diet.*** Legumes are rich in calcium and require less calcium supplementation than grasses.
- ✓ ***The amount of concentrate in the diet.*** Usually, concentrates are low in minerals. Thus, the higher the amount of concentrates in a diet, the higher the need for mineral supplementation.
- ✓ ***The mineral needs of the cow.*** For maintenance, a cow needs 30 to 50 g of calcium and 10 to 30 g of phosphorus per day. Each kg of milk requires about 3 g of calcium and 2 g of phosphorus. When a ration is based on high and medium quality forages, a phosphorus mineral (e.g., monosodium phosphate) may be needed in the range of 0 to 150 g/cow/day. However, with low forage quality or with corn silage, both calcium and phosphorus will need to be supplemented in the range of 50 to 200 g/cow/day.
- ✓ ***To meet Na and Cl demand,*** it is recommended to use 5-7 g of salt per 100 kg live weight and 3 g per 1 kg milk. Highly performing cows should obtain up to 8 g of salt per 1 kg of dry matter in the ration. Depending on the composition of the **trace minerals and vitamins mix** available, the amount of supplementation varies from 10 to 25 g/cow/day.

European feeding standards for dairy cows, based upon the data of DLG (Deutsche Landwirtschaftsgesellschaft, 1997), that is German Agricultural Association are shown in the table 7.1.

Knowing how to determine the amount of concentrate to feed is important. However, determining the percentage of crude protein in the concentrate mix is equally important. When the forage is a legume at an early stage of maturity, a well fertilized grass at an early stage of maturity or a mixture of both, a crude protein in the concentrate mix may vary from 12 to 14%. However, as the stage of maturity of the forage advances and crude protein declines, the crude protein of the concentrate mix needs to be increased between 15 to 18%. Finally, for diets based on low quality forage, crop residues and corn silage, the crude protein of the concentrate mix should be in the range of 18 to 23%.

Optimal fibre content in the ration varies according to the daily milk performance (percentage of dry matter): 28% (under 10kg milk), 24% (11 – 20 kg milk), 20% (20-30 kg milk) and 18-16% (over 30 kg).

During the first 2 month of lactation, beginning from 10-12th day after calving, norm should be increased as is needed to produce additional 5 kg milk (challenge feeding).

The most practical guideline to feed concentrate is: *continue to add small amounts of concentrate as long as the value of the milk production response is greater then the value of the concentrate fed and the amount of the concentrate fed is safe for the cow.*

7.1 Feeding standards for dairy cows
(average fat content 3,8%, protein content 3,2%)

Daily yield, kg	Dry matter (minimum), g	NEL (minimum), MJ	Crude protein (minimum), g	Crude fibre (maximum), g	Ca (minimum), g	P (minimum), g
Live weight 500 kg						
15	14250	78,49	1682	3150	85	61,5
20	15500	94,32	2101	3150	105	77,5
25	16750	110,15	2520	3150	125	93,5
30	18000	125,98	2939	3150	145	109,5
Live weight 550 kg						
15	15250	80,79	1707	3465	87,5	62,85
20	16500	96,62	2126	3465	107,5	78,85
25	17750	112,45	2545	3465	127,5	94,85
30	19000	128,28	2964	3465	147,5	110,85
Live weight 600 kg						
20	17500	98,82	2151	3780	110	80,2
25	18750	114,65	2570	3780	130	96,2
30	20000	130,48	2989	3780	150	112,2
35	21250	146,31	3408	3780	170	128,2
Live weight 650 kg						
20	18500	101,02	2176	4095	112,5	81,55
25	19750	116,85	2595	4095	132,5	97,55
30	21000	132,68	3014	4095	152,5	113,55
35	22250	148,51	3433	4095	172,5	129,55
40	23500	164,34	3852	4095	112,5	81,55

The main purpose of feeding dry cows – to escape over conditioning and to provide all the nutrients necessary for the normal growth and development of fetus. Feeding and managing a cow properly during the dry period will help to realize the cow’s genetic potential for the next lactation and will minimize the health problems that usually arise around calving time (milk fever) or in early lactation (ketosis).

From a feeding view point, the dry period can be divided into two

sub-periods. In the first one, the cow is being dried and the ration should be balanced to meet the maintenance and gestation requirements. In the second period (15 days prior to predicted day of calving), the cow is fed in preparation of the new lactation, that is, progressive feeding the concentrates. A slow transition from predominantly forage diet during the dry period to a high concentrate diet in early lactation helps to avoid the stress associated with the diet changes.

Do it yourself! A dairy producer has a ____ kg cow yielding __kg of milk per day testing ____ % fat. The main part of the ration (roughages) consists of:

5. ____ kg _____; 2. ____ kg _____;

3. ____ kg _____; 4. ____ kg _____;

Such concentrates are available: _____ , _____ , and _____ .

Calculate the concentrate mix and balance the ration to meet the nutritive needs of this lactating cow from the standpoint of energy (NEL), protein and macro elements.

Lesson 8. Individual milk performance recording. **Factors, affecting milk productivity and profitability**

According to the modern breeding standards, cow's milk performance estimation is based upon the following records: fat yield (kg), calculated on the basis of milk yield (kg) and milk percentage (%) for 305 days of lactation or for the short (at least 240 days) completed lactation.

1. Standard lactation yield.

Lactation is the process of milk secretion and excretion from the mammary glands. Time from calving till drying off is called lactation period which averagely lasts from 8 till 10 months. To compare milk performance of cows with different length of lactation, the term of standard lactation or 305 days lactation is used. In fact, lactation could be longer or shorter than 305 days and is called enlarged or shortened lactation. To calculate lactation yield, the milking tests are made on the farm in ten days periods, and the daily amount of milk is multiplied by 10 or 11. The sum of decade yields makes up the monthly yield. The standard lactation yield is obtained by the sum of monthly yields.

2. Average fat percentage of lactation.

The milk fat content of each cow is tested monthly by laboratory methods. Then, by multiplying monthly yields with fat percentage, all monthly yields are recalculated in 1% milk. The sum of 1% milk, divided by the total milk yield makes up the average fat percentage. Thus, the

average fat percentage is calculated as weighed mean.

3. Lactation fat yield is determined by dividing the 1% milk by 100.

Other important characters of milk productivity are milk coefficient and lactation index. Milk coefficient is determined by the amount of milk, produced by cow per 100 kg live weight. Normally it should comprise 1000 kg. Lactation index refers to the amount of 1% milk produced per 1 kg live weight and should be about 30 kg.

Do it yourself! Basing on the farm zootechnical records (table 8.1), monthly yields and fat percentages determine the length of lactation, milk yield, average fat percentage, fat yield, milk coefficient and lactation index for completed lactation and for the first 305 days of cow weighing _____ kg if she calved at _____ and went dried at _____.

8.1 Performance recording of a dairy cow

Months of lactation	Yield recording, kg		Aver. daily yield, kg	Fat records, %	Days in milk	Estimated monthly yield, kg	1% milk, kg
	1 st record	2 nd record					
February							
March							
April							
May							
June							
July							
August							
September							
October							
November							
December							
January							
<i>Estimation milk records for completed lactation</i>							
-	-		-				
-	-		-	-	-	-	
<i>Estimation milk records for standard (305 days) lactation</i>							
-	-		-				
-	-		-	-	-	-	

The main factors that influence milk performance of a cow.

Physiological factors

1. Breed and individual inheritance. In general, total milk production decreases and butter fat content increases by breeds in the following order: Holstein, Brown Swiss, Ayrshire, Guernsey and Jersey. With the Holstein breed, a range in butterfat from 2,6 to 6,0% has been

reported, and with the Jersey breed, from 3,3 to 8,4%.

2. Stage of lactation. Total milk production generally increases for the first 2 months following freshening, and then decreases thereafter. Conversely, the butterfat test is usually higher toward the end of the lactation than soon after freshening.

4. Calving interval. It is most profitable for cows to calve at 12-month, rather than longer intervals. With an 8-week dry period, this means a lactation period of 10 months.

5. Age. Most cows reach maturity and maximum milk production at about 6 years of age, following which there is a decline in production.

6. Size. Within a breed, large cows usually produce more milk than small cows. Each breed has its size and liveweight optimum, exceeding of this optimum results in decreasing the production.

Environmental factors

1. Feeds and feeding. Underfeeding reduces milk production while challenge or lead feeding helps cow to reach her inherited ability for milk production. Some feed ingredients and rations influence milk composition.

2. Length of dry period. A dry period of approximately 60 days is recommended following each lactation period. A short dry period usually results in lower milk production.

3. Frequency of milking. Frequency of milking does result in more total milk produced but the decision as to whether or not it pays to milk more than twice daily will depend on whether the additional milk more than covers the added labour and other costs of obtaining it.

4. Season of calving. Cows calving in the fall months consistently produce more than those calving at other times of the year. Cows calving in the spring produce the least. This difference may be as much as 10-15%. This phenomenon may be due in part of the temperature, but more than likely available feeds, including spring pastures to which fall-calving cows respond so well, may be a factor. It is also noteworthy that present situation on Ukrainian milk market is characterized by prices deviation during the year. Maximum prices for milk are paid at autumn-winter period, and to make more profits producer has to reach maximum milk production at this time, which also favours the fall calvings.

Do it yourself! Calculate and compare on a Gross Margin scale the profits from selling the milk of a cow yielding _____ kg per lactation depending on the season of calving (300 kg of milk was fed to calve).

8.2 The costs of feeds for cow yielding _____ kg

Feeds	Amount (as fed)	Cost per 1 tone, hrn	Total, UAH
Hay			
Haylage			
Silage			
Concentrates			
Green fodder			

8.3 Estimation the profitability of milk production in different seasons of calving.

Traits	Calving seasons			
	January	April	July	October
Cost of milk, UAH				
Cost of calve, UAH				
Total income, UAH				
Production (variable) costs*, UAH				
Gross Margin, UAH				

* *Production costs include feed costs (see table 8.2), costs of veterinary services and drugs (approximately 100 UAH), and artificial insemination costs (75 UAH).*

8.4 Monthly records and milk prices for a cow yielding _____ kg milk (300 kg milk fed to calve)

Months	Milk price, UAH	Month of calving							
		January		April		July		October	
		Daily yield, kg	Income, hrn	Daily yield, kg	Income, hrn	Daily yield, kg	Income, hrn	Daily yield, kg	Income, hrn
January									
February									
March									
April									
May									
June									
July									
August									
September									
October									
November									
December									
Total									
% to conventional (spring) calving									

Lesson 9. Planning the milk production - individual planning and group planning. Milk quality estimation

Making the plan of milk production is the important method of effective management in dairy heard. Milk production can be planned individually for each cow (individual planning) and for the dairy heard as a whole (group planning).

Milk production individual planning.

To prepare the individual plan of milk production for each cow in the heard, such information should be taken into account:

1. Cows' age in lactations;
2. Date of last calving and last insemination;
3. Expected calving date and time of drying off (use the data from gestation table, see App. 3);
4. Milk yield at the last completed lactation;
5. Expected milk yield at the next lactation. Researches has shown that on average cow produces 13,3% milk more at the second lactation then at the first, 8,2% milk more at the third lactation then at the second, 3,2% milk more at the fourth lactation then at the third, 2,2% milk more at the fifth lactation then at the fourth and 2,0% milk more at the sixth lactation then at the fifth. Then the records keep approximately the same up to eighth lactation and finally begin to decline about 5% monthly.

6. Daily and monthly records at the planned lactation. Expected daily yields can be obtained from the daily yields tables depending on the planned yield at the next lactation (see App. 4). Monthly yields are calculated by multiplying daily yields by 30. Then the cows' estimated milk yield at the next lactation is obtained by summing up all the monthly yields.

Do it yourself! Using the dates of calving and insemination and milk performance at the last lactation, make the individual plan of cows' milk production on a farm.

Milk production group planning.

To make the plan of milk production for the group of cows or for the whole herd, such information should be used: expected average herd performance in the planned year, date of last insemination and date of drying off for each cow in the herd (the expected level of milk production is estimated on the basis of the production level achieved at the previous year with accounting for expected feeding condition in the planned year).

Calculation techniques:

1. To determine the expected calving dates in the planned year (using the gestation table (Appendix 3)).

2. On the basis of calving date to determine the dry off months for each cow (2 months before calving). If the date of drying off falls on the first half of the month (before 15th day inclusive), then this very month should be counted for the first month of dry period. Otherwise – the next calendar month is considered to be the first month of dry period. Mark the dry off months with the letter “D” (table 9.1).

3. Insert the number of lactation month or month in milk (the lactation lasts on average 10 months) into the columns “months of year”. The 10th month of lactation is positioned before the first month of dry period. And the first month in milk follows the second dry off month.

4. Estimate the number of cows in milk in each month of the year.

5. Sum up the numbers of months in milk in each calendar month of the planned year.

6. Estimate the average month in milk in each calendar month of the year (the sum of lactation month divided by the number of cows in milk).

7. Out of average month of lactation and the planned performance to estimate the average daily yield in each month of the year (Appendix 2).

8. Calculate the monthly cow yield (daily performance multiplied by 30).

9. Calculate the monthly herd yield (monthly yield of each cow multiplied by the number of cows in milk). To determine the total yearly herd yield.

10. Calculate the monthly and yearly yield per one cow (the so called “fodder cow”).

11. Estimate the error of prediction (absolute and relative).

9.1 Milk production planning on the farm « _____ ».

Expected average milk performance per cow in _____ year: _____ kg

No.	No. of cow	Date of			Months in milk during the year												Total
		insemination	expected calving	drying off	1	2	3	4	5	6	7	8	9	10	11	12	
1																	X
2																	X
3																	X
4																	X
5																	X
6																	X
7																	X
8																	X
9																	X
10																	X
Etc.																	X
																	X
																	X
Number of cows in milk																	
Sum of months in milk																	X
Average month in milk																	X
Average daily yield per one cow, kg																	
Monthly cow yield, kg																	
Monthly herd yield, kg																	
Yield per 1 "fodder cow", kg																	
Error of prediction:																	
absolute ± кг																	
relative ± %																	

Milk quality estimation

Milk and milk product analysis is carried out to determine: freshness, adulteration, bacterial content, milk constituents for payment calculation, milk product composition. The present Ukrainian milk standard provides for such quality indicators for raw milk:

9.2 Milk standard of the Ukraine (3662-97)

Indices	Highest grade	1 grade	2 grade
Flavor and taste	Typical for milk without foreign or unnatural flavour and taste		
Acidity, °T	16-17	18-19	20
Degree of cleanliness	I	I	II
Bacterial insemination, thousands per 1 ml (maximum)	≤300	≤500	≤3000
Somatic cell count, thousands per 1 ml (maximum)	≤400	≤600	≤800
Density, g/liter	≤1027		
Protein content, % (minimum)	≤3,0	≤3,0	≤3,0
Fat content,% (minimum)	≤3,4	≤3,4	≤3,4

The increased demands to food safety and bio-security made it necessary to develop the new approaches to estimation the safety of milk and milk products. The concept of PSL (Product Safety Limits) is being widely discussed and developed in many countries of the world:

PSL = The UNSAFE LEVEL - a SAFETY MARGIN,

where:

UNSAFE LEVEL: the level at or above which there is a *very high risk of illness* if that food is consumed;

SAFETY MARGIN: intended to give increased confidence that a food would not contain pathogens at a level that would be likely to cause illness;

PRODUCT SAFETY LIMIT: the figure below which there is an *extremely low risk* that illness will occur when a food is consumed.

Milk processors usually pay for milk on the basis of butterfat analysis, and a single butterfat test may be used to determine the butterfat content of thousands of litres of milk. Therefore, an accurate and representative sample must be obtained. Irrespective of the tests to be performed the milk shall be thoroughly mixed prior to sampling, by either manual or mechanical means. The sample shall be taken immediately after mixing while the milk is still agitated.

Lesson 10. Estimating farm economical values for milk production and marketing

Having the data on farm production records, calculate yearly milk production, average cow inventory, average daily yields, average yield per cow per year, average fat %, average protein %.

Calculate average milk selling price, when purchase price per 1 centner of standard quality first grade milk (3,4% fat, 3,0% protein) makes up 350,0 UAH. Fat to protein ratio in the purchase price, % - 40:60.

Initial data on milk production and selling

Months of the year	Number of cows	Number of "cow-days"	Av. daily yield, kg	Total yield, centner	Milk sold, kg	Fat, %	Amount of 1% milk by fat	Protein, %	Amount of 1% milk by protein
I	110			573,6		3,7		3,2	
II	110			554,2		3,7		3,2	
III	110			558,4		3,7		3,3	
IV	112			593,7		3,6		3,3	
V	115			669,4		3,5		3,2	
VI	117			710,5		3,5		3,2	
VII	118			620,8		3,4		3,0	
VIII	112			593,4		3,6		3,2	
IX	114			566,9		3,7		3,3	
X	110			541,5		3,8		3,3	
XI	110			539,6		3,9		3,4	
XII	110			502,6		3,9		3,4	
Total	X		x			X		x	
Average	X	x		X	X		x		x

Average cow inventory = \sum "Cow-days" / 365

Av. daily yield = Total yield / "Cow-days"

Av. yield per cow per year = \sum Total yield / \sum "Cow-days"

Milk marketability - 90%

Quality distribution of milk sold: "extra" – 80%, "prime grade" – 10%, "first grade" – 10%

Procedure of actual purchase prices calculation.

1. Calculate the price for 1% fat and 1% protein in the standard quality first grade milk:

- 1% fat price = $350 \times 0,4 : 3,4 = \underline{\hspace{2cm}}$ UAH

- 1% protein price = $350 \times 0,6 : 3,0 = \underline{\hspace{2cm}}$ UAH

2. Actual fat price in milk = 1% fat price x Average fat %

3. Actual protein price in milk = 1% protein price x Average protein %

4. Actual purchase price for “**first grade**” milk = actual fat price + actual protein price

5. Actual purchase price for “**extra grade**” milk = actual purchase price for “first grade” milk x 1,25

6. Actual purchase price for “**prime grade**” milk = actual purchase price for “first grade” milk x 1,15

7. Actual purchase price for “**second grade**” milk = actual purchase price for “first grade” milk x 0,90

8. Actual purchase price for “**low grade**” milk = actual purchase price for “first grade” milk x 0,70

Yearly returns on milk = (\sum “Extra grade” milk x actual purchase price for “extra grade” milk) + (\sum “Prime grade” x actual purchase price for “prime grade” milk) + (\sum “First grade” x actual purchase price for “first grade” milk).

Average milk selling price = Yearly returns on milk / \sum Total milk sold

Lesson11. Estimation the sow reproductive traits.

Production testing of swine

The productivity of the sow is the foundation of commercial pork production. The biology of swine growth and development imposes constraints on herd management, facilities design, and productivity. The boundaries of some biological parameters are relatively inflexible, but for others, the boundaries are highly influenced by genetics or the environment.

Inflexible parameters of swine production:

1. Gestation length: 114 days (± 2 days) or 3 months, 3 weeks, 3 days;
2. Estrus interval. The sow is polyestrous, with a period of lactational anestrus occurring until after weaning. The estrus cycle length averages 21 days. Return to estrus occurs after the recovery period, or 4-7 days post-weaning. Gilts come in to first estrus around 8 months of age. Estrus (heat behaviour) occurs for 2-3 days,

averaging 60 hours in mature sows, but is only about 48 hours long in gilts. Ovulation occurs during the last third of estrus

3. Age at puberty: time at which first estrus occurs in females, usually at 6 months of age, but depends on breed, environment and season of the year.

Flexible parameters of swine production:

1. Growth rate and feed conversion efficiency. Both these parameters characterise the growth performance of swine and are largely influenced by feeding (quality protein diets), genetics, gender and age.
2. Fecundity. Fecundity is highest in sows at 2 to 4 years of age. Gilts average 10-15 ova per cycle. Embryonic survival rate is 65%-75%, resulting in litter sizes of 8 to 12 piglets. Very high ovulation rates do not yield greater litter sizes. Recent studies suggest fecundity may be linked to the presence of a specific estrogen receptor. In addition, fecundity is strongly linked to lactational feed intake. Limiting feed intake in gestation leads to greater feed intake during lactation. High feed intake in lactation results in good milk production, high piglet weights at weaning, short wean to estrus intervals, and maximal ovulation rates.

Swine production is usually compartmentalized into two phases: breeding (reproduction) and growing. This division arises because the inputs to these two phases are quite different from one another. A major reason for the compartmentalization is the need to segregate young animals from older for disease control.

The following characteristics are being used to measure sows reproductive traits :

1. Litter size at birth;
2. Litter size at weaning;
3. Survival rate = (litter size at birth / litter size at weaning) x 100%;
4. Birth weight of pigs;
5. Litter weight at weaning (development);

To estimate the economy of production, such additional traits are useful:

1. Daily rate of gain from weaning to marketing;
2. Efficiency of feed utilization;
3. Carcass characteristics: length; backfat thickness; loin lean area (indication of muscling); percent ham, based on carcass weight; percent lean cuts, based on carcass weight.

Do it yourself! Having the data set of sows life individual records, estimate the average reproduction traits of a group of sows.

Sow registration no.	Number of farrowings	Av. litter size at birth	Av. litter size at weaning	Av. birth weight	Av. weight at weaning

Note, that when estimating average reproduction traits for a group of sows, average weight mean values should be used rather than average arithmetic mean values.

Lesson12. Animal flow strategies in swine production. Calculation the heard parameters of a swine enterprise

20-30 years ago, the standard was to house all production phases under one roof. As the traditional swine management scheme, "one site" was perceived as cheaper and easier than anything else. Health concerns have driven the industry to segregate production among several sites to minimize contact between pigs of different ages. Three types of swine production compartmentalisation are now in use:

- ✓ One site = all under one roof
- ✓ Two site = breeding herd segregated from growing herd
- ✓ Three site = nursery (wean to 9 weeks of age) further separated

The current trend is to combine the nursery phase with grow-finish, especially as capability to produce and manage high-health pigs increases.

Animal flow strategy dictates facility design. There are two main principles of animal flow strategies: ***all in-all out (AIAO)*** and ***continuous flow***.

AIAO means that animals of the same age or size are housed together in order to decrease the opportunities for disease entities to spread. This housing may be the same room in a barn, or ideally, the same barn, with no other ages of animals in it.

Advantages: disease spread can be better contained, animals are less stressed when they remain with a familiar social group throughout development, and cleaning and disinfecting between groups is possible.

Disadvantages: animals must be put into space which must be large enough to house them when they have grown. Space is less efficiently allocated.

Continuous flow means that animals are trickle-added to a group, as they are old enough or large enough. Animals of many different stages of

development may be housed in close proximity to one another. The facilities are never empty.

Advantages: space is efficiently used, because pigs can be moved to larger pens as they grow, and new arrivals can replace them in the smaller pens.

Disadvantages: animals of varying immunocompetence are housed together facilitating disease spread, stress levels can be heightened with changing social groups, adequate cleaning and disinfecting are not feasible.

These animal flow principles should be applied in estimation the heard parameters for a modern swine enterprise. The basic point is segregation the heard into uniform pig groups, accommodated in separate pens or barns. These could be achieved through grouped farrowing. Farrowing at the big enterprise is almost always AIAO so sows are grouped to farrow on the same day. Rooms are sized to accommodate 1 group. The number of rooms is dictated by:

- ✓ frequency of farrowing (semi-weekly, weekly, biweekly, monthly)
- ✓ weaning age

The number of farrowing groups is dictated by:

- ✓ frequency of farrowing
- ✓ farrowing interval

For instance, if farrowing is weekly, then we need 52 groups of sows farrowing to keep the facility running at maximum capacity. And if sows farrow about 2,2 times per year, which means that the sows which farrowed in the beginning of the year will be ready to farrow again in mid-year, we need $52/2,2$ or 23,6 groups. It is inefficient to have 0,6 of a group, and we will not have space for the progeny if we have 24 groups, so the number of farrowing groups is 23.

As an example, let's calculate the heard parameters for a swine enterprise with annual production of 6000 finished hogs.

Initial data:

- sows reproduction cycle: 180 days, including 115 days of gestation, 60 days of lactation and 5 days of recovery and breeding;
- rate of insemination: 0,78;
- litter size at birth: 10 heads;
- litter size at weaning: 8,5 heads;
- survival after weaning: 0,95;
- sows culling percentage: 30%;
- farrowing interval (rhythm of production): 10 days.

Calculations:

Step 1. Estimation the annual figures and group size of various swine categories.

1. Total number of sows at the enterprise:

$$S_{total} = \frac{P \times R}{365 \times k_{insem.} \times l_{weaned} \times k_{surv.}},$$

where: S_{total} – total number of sows;

P – annual hog production;

R – sows reproduction cycle;

$k_{insem.}$ - rate of insemination;

l_{weaned} – litter size at weaning;

$k_{surv.}$ – survival after weaning.

$$S_{total} = \frac{6000 \times 180}{365 \times 0,78 \times 8,5 \times 0,95} = 470 \text{ sows.}$$

2. Number of farrowings ($N_{farrow.}$) per sow per year:

$$N_{farrow} = \frac{365 \times k_{insem.}}{R} = \frac{365 \times 0,78}{180} = 1,58 \text{ farrowings per sow per year;}$$

3. Annual number of farrowings ($Y_{farrow.}$) at the enterprise:

$$Y_{farrow} = S_{total} \times N_{farrow} = 470 \times 1,58 = 743 \text{ farrowings per year;}$$

4. Piglets born per year (Y_{birth}):

$$Y_{birth} = Y_{farrow} \times l_{birth} = 743 \times 10 = 7430 \text{ piglets born per year,}$$

where l_{birth} – litter size at birth;

5. Piglets weaned per year (Y_{weaned}):

$$Y_{weaned} = Y_{farrow} \times l_{weaned} = 743 \times 8,5 = 6315 \text{ piglets weaned per year;}$$

6. Hogs finished per year ($H_{finish.}$):

$$H_{finish.} = Y_{weaned} \times k_{surv.} = 6315 \times 0,95 = 5999 \text{ hogs finished;}$$

7. Number of sows culled per year (S_{culled}):

$$S_{culled} = \frac{S_{total} \times k_{culling}}{100} = \frac{470 \times 30}{100} = 141 \text{ sows culled;}$$

8. Number of sows for replacement ($S_{replace.}$): $S_{replace.} = S_{culled} = 141$ sows;

9. Number of production outputs: $n = 365 : r = 365 : 10 = 36,5$ times,

where: r – rhythm of production (farrowing interval);

10. Group size of sows, selected for insemination:

$$G_{insem.} = \frac{r \times S_{total}}{R} = \frac{10 \times 470}{180} = 26 \text{ sows;}$$

11. Group size of “suspected” sows, whose gestation has not been proved:

Since the sows are polyestrous and the estrus occur every 21 days,

the gestation may be proved only 21 days after insemination, thus all the inseminated sows are forming the group of suspected sows:

$$G_{suspect.} = G_{insem} = 26 \text{ sows};$$

12. Group size of gestating sows:

$$G_{gest.} = G_{insem.} \times k_{insem.} = 26 \times 0,78 = 20 \text{ sows};$$

13. Group size of lactating sows (on average, about 10% of the farrowed sows have small litters and low milking ability):

$$G_{lact.} = 20 - 20 \times 0,10 = 18 \text{ sows};$$

14. Group size of weaners:

$$g_{wean.} = G_{gest.} \times l_{weaned} = 20 \times 8,5 = 170 \text{ pigs};$$

15. Group size of growing-finishing hogs:

$$g_{finish.} = g_{wean.} \times k_{surv.} = 170 \times 0,95 = 162 \text{ hogs};$$

16. Number of sows culled in each farrowing interval:

$$s_{culled} = \frac{S_{culled}}{n} = \frac{141}{36,5} = 4 \text{ sows};$$

17. Total size of growing-finishing group together with sows culled:

$$G_{finish.} = g_{finish.} + s_{culled} = 162 + 4 = 166 \text{ heads};$$

18. Group size of sows for replacement:

$$s_{replace.} = s_{culled} = 4 \text{ sows};$$

19. Reserve or buffer (*B*) group of sows (to have the adequate number of sows ready for insemination, a so-called reserve or buffer group of sows, from which the sows in heat could be selected for breeding, is needed):

$$B = \frac{21 \times G_{insem.}}{R} = \frac{21 \times 26}{10} = 55 \text{ sows};$$

Step 2. Estimation of the permanent swine number in each group.

The permanent swine number in each group is influenced by group size and period of duration in each group:

$$N_i = G_i \times \frac{D_i}{r},$$

where: N_i – permanent number of swine in *i*-group;

G_i – size of *i*-group;

D_i – period of duration in *i*- group;

r – rhythm of production;

20. Permanent number of suspected sows, $N_{suspect.}$ (period of duration 22 days): $N_{suspect.} = 26 \times \frac{22}{10} = 57 \text{ sows};$

21. Permanent number of gestating sows, $N_{gest.}$ (period of duration 86

days): $N_{gest.} = 20 \times \frac{86}{10} = 172$ sows;

22. Permanent number of lactating sows, $N_{lact.}$ (period of duration is 67 days=7 last days of gestation + 60 days of lactation): $N_{lact.} = 18 \times \frac{67}{10} = 121$ sows;

23. Permanent number of empty sows, N_{empty} :

$$N_{empty} = S_{total} - N_{suspect} - N_{gest.} - N_{lact.} = 470 - 57 - 172 - 121 = 120 \text{ sows};$$

24. Permanent number of sucklers, $N_{suckl.}$:

$$N_{suckl.} = N_{lact.} \times l_{birth} = 121 \times 10,0 = 1210 \text{ pigs};$$

25. Permanent number of weaners, $N_{weaners.}$ (period of duration 65 days):

$$N_{weaners} = 170 \times \frac{65}{10} = 1105 \text{ pigs};$$

26. Permanent number of growing-finishing hogs, $N_{finish.}$ (period of duration 115 days): $N_{finish} = 166 \times \frac{115}{10} = 1909$ pigs;

27. Permanent number of boars, $N_{boars.}$ Depending of the mating system (hand-mating or artificial insemination), the number of sows one boar can service per year is 15 sows in hand-mating and 100-200 sows in artificial insemination. In our example (hand-mating system):

$$N_{boars} = \frac{S_{total}}{15} = \frac{470}{15} = 31 \text{ boars};$$

28. Total permanent swine number at the enterprise, N_{total} :

$$N_{total} = N_{suspect.} + N_{gest.} + N_{lact.} + N_{empty} + N_{suckl.} + N_{weaners} + N_{finish} + N_{boars};$$

$$N_{total} = 57 + 172 + 121 + 120 + 1210 + 1105 + 1909 + 31 = 4725 \text{ pigs}.$$

The estimated permanent numbers of various pig groups determine buildings capacity, daily fodder demand and supply of other resources.

Do it yourself! Estimate the heard parameters for the swine enterprise with annual production _____ of finished hogs, having the following initial data:

- ✓ sows reproduction cycle: ____ days, including 115 days of gestation, ____ days of lactation and ____ days of recovery and breeding;
- ✓ rate of insemination: _____;
- ✓ litter size at birth: ____ heads;
- ✓ litter size a weaning: ____ heads;
- ✓ survival after weaning: _____;
- ✓ sows culling percentage: _____ %;
- ✓ farrowing interval (rhythm of production): _____ days.

Results of calculations can be summarised in form of the following table:

13.1 Heard parameters for the swine enterprise
with annual production of 6000 hogs

Herd parameter	Size	Herd parameter	Size
Sows, total	470	<i>Group sizes:</i>	
Reproduction cycle:	180	- sows for breeding	26
- gestation	115	- sows suspected	26
- lactation	60	- sows gestating	20
- recovery and breeding	5	- sows lactating	18
Rate of insemination	0,78	- weaners	170
Ann. number of farrowings per sow	1,58	- growing-finishing hogs	162
Litter size at birth	10	- culled sows	4
Litter size at weaning	8,5	- growing-finishing, total	166
Survival after weaning	0,95	- sows for replacement	4
Sows culling percentage,%	30	<i>Permanent numbers</i>	
Rhythm of production, days	10	- boars	31
Ann. number of production outputs	36,5	- sows empty	120
Ann. number of farrowings	743	- sows suspected	57
Piglets born per year	7430	- sows gestating	172
Piglets weaned per year	6315	- sows lactating	121
Hogs finished per year	5999	- weaners	1105
Sows culled per year	141	- growing-finishing	1909
Sows for replacement	141		
Buffer group	55	<i>Swine, total</i>	4725

Lesson 13. Feeding swine. Making the diets for various pig groups

Feed accounts for approximately 65 to 75% of the total cost of producing pork. Thus, knowledge of feeding swine is important from an economic standpoint. Swine differ in the kinds and amounts of nutrients needed. The need is influenced by age, function, environment and other factors.

Feeds and feed additives commonly used in pig diets can be classified as:

1. Energy feeds: corn, barley, sorghum, wheat, oat, fats and oils;

2. Protein feeds: soybean meal, peas, sunflower cake and sunflower meal, fish meal, meat and bone meal, dried skim milk;
3. Water;
4. Minerals: major and trace minerals;
5. Vitamins: fat-soluble and water-soluble;
6. Growth stimulators: antibiotics, probiotics, organic acids.

For swine, nutrients quality is just as important as quantity. **Quality of protein** has great significance in swine nutrition. This term is used to describe the amino-acid balance of proteins. A protein is said to be of good quality when it contains all the essential amino acids in proper proportions and amounts, and to be of poor quality when it is deficient in either content or balance of essential amino acids. From this it is evident that the usefulness of a protein source depends upon its amino acid composition, because the real need of the pig is for amino acids and not for protein as such. It is possible for pigs to perform better on a 12% protein ration, well balanced for amino acids, than on a 16% protein ration having a poor amino acid balance.

Types of pig rations:

1. Prestarter – normally fed to pigs beginning at 7 days of age until they reach approximately 9 kg. This ration must contain high quality protein sources like milk, whey, soybean meal. The recommended protein content varies from 20-24%, with high level of amino acids: 1,4% lysin, 0,8% threonin, 0,2% tryptophan. Prestarter should contain a minimum of 13,3 MJ ME per 1 kg.

2. Starter – fed to weaned pigs from 9 to 20 kg weight. Protein content declines to 18-20% with amino acid levels of 1,15% lysin, 0,75% threonin and 0,18% thryptophan. A minimum of 13,3 MJ ME/kg energy allowance is also recommended.

Note, that early availability and good quality prestarter and starter rations to young pigs will result in:

- a. more uniform pigs with fewer runts,
- b. heavier weaning weights,
- c. less mortality of baby pigs,
- d. lower weight loss by the sow.

3. Grower-finisher rations are rations with medium protein and relatively low amino acid content and with energy allowance about 13,0 MJ ME/kg. Grower is fed to pigs from 20 until about 55-60 kg weight. It should contain 15-17% protein, 0,75-0,85% lysine, 0,50% threonine, and 0,13% tryptophan. Then the pigs should be switched to a finisher ration. A finisher normally contains 13-15% protein, 0,60-0,70% lysine, 0,40% threonine and 0,11% tryptophan.

Note, that grower-finisher formulations allow cheaper ingredients, most readily available at the farm.

Types of sow rations and phase feeding sows:

1. Low energy ration (gestation ration): a ration with low energy (12,0 MJ ME/kg), low protein (12-12,5%) and low amino acids allowances (0,6% lysine, 0,39% threonine and 0,12% tryptophane).

Low energy rations should be fed to sows at early gestation, that is, at the first two-thirds of the gestation period (first 12 weeks). Feeding strategy at this stage should be aimed to cover the usual maintenance needs of a sow. It is important that the condition of dry sows should be regulated so that they are neither too fat nor too thin at farrowing time. Overly fat sows may have difficulty in farrowing and give birth to weak or dead pigs. Sows that are too thin at farrowing tend to become suckled down during lactation. Thus, limited feeding is a must for gestating gilts and sows. The daily feed allowance for sows at the first two-thirds of gestation should not exceed 2,5 kg of low energy feed.

2. High energy ration (lactation ration): a ration with middle protein (16,5%), high energy (13,2 MJ ME/kg) and high amino acids allowances (0,9% lysine, 0,7% threonine, 0,18% tryptophane)

This ration should be started to feed during the latter third of gestation period. It is estimated that approximately two-thirds of the growth of the fetus is made during the last month of the gestation period. Needs for protein, amino acids, vitamins and minerals rapidly increase. This requires increased nutrients intake. The recommended daily feed allowance for gestating sows at this stage is 3,0 kg.

The nutritive requirements of a lactating sow are more rigorous than those during gestation. They are very similar to those of a milk cow, except they are more exacting relative to the quality of proteins and vitamins. After farrowing the lactating sow should be provided with liberal feed allowance – up to 6,0-6,5 kg of lactation ration daily.

At weaning time the sows' ration is half reduced to stop milk production, and 3 days after breeding begins flushing. **Flushing sows** is the practise of conditioning or having the sows gain in weight just prior to breeding. The purpose of flushing is to increase the number of ova shed during estrus. The sow is allowed about 4 kg of high-energy ration daily. Immediately after breeding, the females should be put back on limited feeding with gestation ration. Continuation of high level of feeding after breeding will result in higher embryo mortality.

The recommended allowances of the various important nutrients that should be included in ration formulation for optimum performance are given in the table . These allowances have been formulated on the basis of

the data from Iowa State University (1988) and DLG (Deutsche Landwirtschaftsgesellschaft, 1997).

14.1 Recommended nutrient allowances for swine (per 1 kg ration)

Nutrient	Sows		Young pigs		Grower-finisher pigs	
	Gestation	Lactation	Prestarter	Starter	Crower	Finisher
Metabolisable Energy, MJ	12,0	13,2	13,3	13,3	13,0	13,0
Crude protein, %	12,0	16,5	20-24	18-20	15-17	13-15
Lysine, %	0,60	0,90	1,40	1,15	0,92	0,80
Threonine, %	0,39	0,70	0,80	0,75	0,55	0,50
Tryptophan, %	0,12	0,18	0,20	0,18	0,18	0,16
Salt, %	0,40	0,50	0,25	0,25	0,25	0,25
Calcium, %	0,75	0,75	0,90	0,80	0,60	0,55
Phosphorus, %	0,60	0,60	0,70	0,65	0,50	0,45
Copper, mg	5	5	8	8	4	2
Zinc, mg	50	50	100	100	50	25
Vitamin A, IU	4400	4400	4400	4400	2200	1100
Vitamin D, IU	440	440	440	440	220	110
Vitamin E, IU	22	22	22	22	11	5,5

Do it yourself! A swine producer has the following energy and protein feeds at the disposal:

- 1) _____, price _____ hrn/kg;
- 2) _____, price _____ hrn/kg;
- 3) _____, price _____ hrn/kg;
- 4) _____, price _____ hrn/kg;
- 5) _____, price _____ hrn/kg;
- 6) _____, price _____ hrn/kg.

Make recommendations on complete rations formulation (from the standpoint of protein allowances); estimate the price of 1 kg ration for each swine group.

Lesson 14. Estimation of pig production profitability on a Gross Margin scale

Do it yourself! One farmer has _____ sows and is specialized on producing the weaned piglets. Another farmer purchases these weaners and rears them to the market condition. Calculate the fodder demand and estimate the profitability of swine production at these tow farms using the Gross Margin approach:

Step 1. Calculate the yearly number of pigs produced by _____ sows using such parameters:

- Gestation period - 115 days;
- Lactation period - ____ days;
- Period of recovery and breeding - _____ days;
- Litter size at weaning - _____ pigs.
-

Step 2. Calculate the yearly fodder demand for _____ sows with litter from birth till weaning

Phase	Days	Daily demand, kg	For 1 cycle	For 2 cycles
Empty sows		3,0		
First tow-third of gestation		3,0		
Second third of gestation		3,5		
1-5 days after farrowing		3,0		
6-15 days after farrowing		5,0		
16-45 days after farrowing		6,5		
Creep feeds (prestarter)	-	5,0 kg per 1 piglet		
<i>Sum for sows</i>	-	-		
<i>Total for ____ sows</i>	-	-		
<i>Sum for piglets</i>	-	-		
<i>Total for ____ piglets</i>	-	-		

Step 3. Calculate the fodder demand for finishing ____ hogs.

Items	Period of growing-finishing				Total
	I	II	III	IV	
Age, days	45-90	91-120	121-150	151-180	-
Duration	45	30	30	30	135
Average live weight at the end of period	15-37	37-58	57-80	80-110	95
Daily demand at the end of period, kg	1,8	2,2	2,8	3,5	-
Fodder demand per 1 head for the period					
Fodder demand for ____ hogs					

Step 4. Estimate the profitability of keeping of ____ sows for selling weaners using the Gross Margin method.

Items	Calculations	Sum, UAH
Market price of weaned pigs	____ pigs x ____ UAH/pig	
Variable costs:		
fodder	____ kg x ____ UAH/kg	
vet. treatment	____ UAH/pig x ____ pigs	
other costs	____ UAH/pig x ____ pigs	
<i>Total variable costs</i>		
Gross Margin		

Step 5. Estimate the profitability of finishing _____ hogs till 110 kg weight using the Gross Margin method*.

Items	Calculations	Sum, UAH
Purchase price of weaned pigs , UAH.	15 kg x ___ UAH/kg x _____ pigs	
Variable costs: fodder vet. treatments other costs <i>Total variable costs</i>	____ kg/pig x ____ UAH/kg x __pigs ____ UAH/pig x ____ pigs ____ UAH/pig x ____ pigs	
<i>Market price of finished hogs</i>	110 kg/hog x __ UAH/kg x ____ hogs	
Gross Margin		

**Gross Margin = Gross income – Variable costs.*

Lesson 15. Estimation the egg productivity. Planning the egg production. Egg grading

Egg yield is the product of tow forces: rate of laying and length of the laying period before moulting. Among the **factors**, influencing egg production, the following are of especial importance.

1. Genetic pattern of the breed of hen. Maximum production of top-quality eggs starts with a closely controlled breeding program emphasizing favourable genetic factors. The Single Comb White Leghorn hen dominates today's egg industry. This breed reaches maturity early, utilizes its feed efficiently, has a relatively small body size, adapts well to different climates and produces a relatively large number of white-shelled eggs, the colour preferred by most consumers. Where brown-shelled eggs are more favoured, the Rhode Island Red, New Hampshire and Plymouth Rock breeds predominate in these regions of country.

2. Hen's age at egg-laying maturity. A pullet is said to be sexually mature when she lays her first egg. Although early starters lay more eggs, maturity too early results in many small eggs. On the average, Leghorns become sexually mature at between 170 and 185 days of age. Sexual

maturity can be greatly advanced or delayed by environment, that is by the lighting and feeding programs followed during growing.

3. Resistance to disease. Selective breeding is reinforced by good sanitation and vaccination.

4. Light control. Of primary importance both during the growing and laying periods, controlled, low-intensity light can be used to delay sexual maturity until the bird's body is big enough to produce larger eggs. Today's laying hen doesn't need to depend upon the fickle sun to tell her when laying time has arrived. Intensity and duration of light can be adjusted to regulate production.

5. Quality of feed. Since more is known about the nutritional requirements of the chicken than of any other domestic animal, it is not surprising that rations are scientifically balanced to assure layer health along with optimum quality eggs at least cost.

6. Temperature. Laying houses maintained between 14 and 26°C are desirable.

7. Humidity. A relative humidity between 40 and 60% is best.

8. Replacing or moulting the flock. Moulting, or loss of feathers, is a natural occurrence common to all birds regardless of species. As the hen ages, egg quality declines and, at about 18 to 20 months of age, moulting occurs and egg production ceases. While some flocks are sold for slaughter at this point, replacement is costly. A fairly common practice is to place the flock into a controlled moult. After a rest period of 4 to 8 weeks, the birds start producing again. Poultrymen have found that with two periods of controlled moulting, one at 14 months of age and another at 22 months, egg quality is more consistent than with one moult at 18 or 20 months.

9. The laying house. In today's egg-laying facilities, temperature, humidity and light are all controlled and the air is kept circulated. The building is well insulated, windowless (to aid light control) and is force-ventilated. Birds are either given the run of the floor area or are housed in cages. Most new construction favours the cage system because of its sanitation and efficiency, but floor operations are also in use.

10. Feeding. Because care and feeding of hens, maintenance, sanitation and egg gathering all take time and money, there is a strong trend toward automation whenever possible. Automatic feeders, activated by a time clock, move mash through troughs in the floor or past the cages. Birds at floor level drink from troughs. Those in cages may sip from such sophisticated accessories as self-cleaning drinking cups or nipple valves.

11. Handling. The moment an egg is laid, physical and chemical changes begin to conspire against freshness. Warm temperatures encourage those changes, so newly laid eggs must be gathered frequently and

refrigerated quickly. Some eggs are still gathered by hand, but in most production facilities automated gathering belts do the job. Gathered eggs are moved into refrigerated holding rooms where temperatures are maintained between 5 and 7°C. Humidity is relatively high to minimize moisture loss but should not exceed 80%. Sometimes eggs are oiled as they are gathered.

To **measure the egg production** of an enterprise, such figures could be used:

1) Laying rate – number of eggs expressed in percent to the flock size:

$$\text{Laying rate} = \frac{\text{Number of eggs produced}}{\text{Number of hens}} \times 100\% ;$$

If a flock of 1000 hens produces 800 eggs then the laying rate makes up 80% (800 x 100% /1000);

2) Annual egg production per “average” hen.

Beginning from the moment of establishing the heard of layers, the flock size is constant changing, due to culling, mortality and other losses. This calls for use the average values, characterizing the heard size changes during the year. To calculate the annual “average” hen number, we should first estimate the average monthly hen number. The latter is half the sum of hen numbers at the beginning and at the end of the month. The sum of average monthly hen numbers, divided by 12 represents the average annual hen number.

$$\text{Then: Egg production per "average" hen} = \frac{\text{Total annual egg production}}{\text{Average annual hen number}}$$

When estimating hen numbers at the end of the month, and monthly egg production, such normatives as shown in the table below could be applied.

Egg grading. The grading of eggs involves their sorting according to quality, size, and weight, and other factors that determine their relative value. Ukrainian standards for quality of shell eggs have been developed on the basis of such interior quality factors as condition of the white and yolk, the size of the air cell, and the exterior quality factors of cleanliness and soundness of the shell. These standards cover the entire range of edible eggs. Eggs are also classified according to weight (or size), expressed in gram per egg. The *extra large* eggs exceed 65 g weight, the *large* eggs are weighing between 60 and 55 g, the *medium* eggs – between 50-55 g and the *small* – less then 50 g. Egg grading, then, is the grouping of eggs into lots according to similar characteristics as to quality and weight. Although colour is not a factor in the Ukrainian standards of grades, eggs are sometimes sorted for colour and sold as either *whites* or *browns*.

16.1 Approximate norms of losses and monthly egg production in a layer heard

Age of layers, months	Heard size, in % from initial size	Culling % from initial heard size	Average monthly egg production per layer, eggs
5 – 6	100	1,5	6
6 – 7	98,5	1,5	16
7 – 8	97,0	1,5	21
8 – 9	95,5	1,5	24,5
9 – 10	94,0	1,5	24
10 – 11	92,5	1,5	23
11 – 12	91,0	2,0	21,5
12 – 13	89,0	2,0	20,5
13 – 14	87,0	3,0	19,5
14 – 15	84,0	3,0	17,0
15 – 16	81,0	3,0	16,5
16 – 17	78,0	78,0	15,5

Egg size is correlated with a number of factors, among them are:

1) body size – the larger breeds generally produce large eggs; 2) age of pullets – egg size increases from the time pullets start to lay until somewhere about six months later; 3) weather – the size of eggs declines during the hot summer months; 4) second year – the eggs produced during the second year are larger than those produced the first year; 5) total eggs laid – there is a tendency toward a decline in eggs size with the total number of eggs laid in the year.

Do it yourself! The egg producing enterprise has a flock of _____ pullets at the beginning of the year. Determine the monthly heard size and estimate the total annual egg production and egg production per “average” hen. Present results in form of the following table.

Herd size and egg production of the enterprise

Months of the year	Monthly heard size				Eggs per hen	Total egg production	
	At the beginning	At the end	Culling				Average heard size
			%	heads			
January							
February							
March							
April							
May							
June							
July							
August							
September							
October							
November							
December							
Total	-	-	100				

Lesson 16. Poultry feeding. Making and balancing the diets for laying hens. Phase feeding

Feeds used in poultry rations.

A wide variety of feedstuffs are used in poultry rations. Broadly speaking, they may be classed as energy feedstuffs, protein supplements, mineral supplements and vitamin supplements.

Energy feedstuffs. The major energy sources of poultry feeds are cereal grains and their by-products and fats. Corn is the most important grain used by poultry, supplying about one third of the total feed which they consume. Animal and vegetable fats are now used extensively in poultry feed. In addition to their high energy value, fats reduce the dustiness of feed mixtures, increase their palatability, and improve the texture and appearance of the feed. However, the use of fats in poultry feeds requires good mixing equipment. Also, it is necessary that the fat be properly stabilised in order to prevent rancidity.

Protein and amino acid supplements. The usefulness of a protein feedstuff depends upon its ability to furnish the essential amino acids required by the bird, the digestibility of the protein, and the presence or absence of toxic substances. As a general rule, several different sources of protein produce better results than single protein sources. Both animal and vegetable protein supplements are used for poultry. Among the animal protein supplements commonly used in poultry rations are meat by-products, milk by-products, marine products. The common vegetable protein supplements used in poultry feeding include the oilseed meals (soybean meal, sunflower meal), alfalfa meal and other legume meals. In poultry nutrition, special attention needs to be given to supplying the amino acids lysine, methionine and cystine, and tryptophan. These are referred to as the critical amino acids in poultry nutrition.

Mineral supplements. Mineral supplements are required by poultry for skeletal development in growing birds, for eggshell formation in laying hens, and for certain other regulatory processes in the body. The present consensus among poultry nutritionists is that the diet for laying hens should have a minimum allowance of 3 to 4% calcium. The common calcium supplements used in poultry feeding are ground limestone, crushed oyster shells, bone meal, and chalk. Most of the phosphorus in plant products is in organic form and not well utilised by chicks and hens. Hence, for poultry, emphasis is placed upon inorganic phosphorus sources in feed formulation: bone meal, dicalcium phosphate, monocalcium phosphate, monosodium phosphate. Salt is added to most poultry rations at 0,2 to 0,5% level, depending primarily upon the amount of sodium required.

Vitamin supplements. In modern poultry feed formulation and

production, *premixes* are used to provide both vitamin and mineral needs for poultry.

Nutritive requirements. The nutritive requirements of poultry vary according to species, according to age and according to the type of production. To be successful, rations must meet the nutritive requirements of the birds to which they are fed. Some nutrient requirements for leghorn-type chickens are shown in the following table (table 17.1).

17.1 Nutrient requirements for leghorn-type chickens for growing, laying, breeding, (per 1 kg diet)

Nutrient	Growing			Laying	Breeding
	0-6 weeks	6-14 weeks	14-20 weeks		
Met. Energy, MJ	12,1	12,1	12,1	12,1	12,1
Crude Protein, %	18,0	15,2	12,0	14,5	14,5
Lysine, %	0,85	0,60	0,45	0,80	0,68
Meth.+Cys.,%	0,60	0,50	0,40	0,60	0,60
Thryptophan, %	0,17	0,14	0,11	0,17	0,17
Ca, %	0,80	0,70	0,60	3,40	3,40
P, %	0,40	0,35	0,30	0,32	0,32
Na, %	0,15	0,15	0,15	0,15	0,15
Cu, mg	8,00	6,00	6,00	6,00	8,00
Zn, mg	40,00	35,00	35,00	50,00	65,00
Vit. A, IU	1500	1500	1500	4000	4000
Vit. D, IU	200	200	200	500	500
Vit. E, IU	10	5	5	5	10
Vit. B ₁ , mg	1,8	1,3	1,3	0,8	0,8
Vit. B ₂ , mg	3,6	1,8	1,8	2,2	3,8
Vit. B ₁₂ , mcg	9,0	3,0	3,0	4,0	4,0

The vast majority of large poultry enterprise feed complete rations, in which all of the nutrients needed by the bird are provided in the quantities necessary. Little or no grain is fed along with this ration because such feeding would destroy the balance of nutrients provided by the complete ration. Laying or breeding hens are sometimes provided with a supplementary source of calcium, to which they are given free access. The daily feed requirement of a mature hen is varying from 110 to 120 g of complete ration, depending on body weight, egg production and temperature. It was estimated that increase of the environment temperature by 1°C causes the decrease in daily feed intake by 1,5 g per hen.

Phase feeding. Phase feeding refers to changes in the laying hens' diet (1) to adjust to age and stage of production of the hen, (2) to adjust for season of the year and for temperature and climatic changes, (3) to account for differences in body weight and nutrient requirements of different strains of birds, and (4) to adjust one or more nutrients as other nutrients are

changed for economic or availability reasons. Researches has shown that a hen, laying at the rate of 60% has different nutritional requirements than one laying at the rate of 80%; hens have different requirements in summer and in winter; a 24-week-old layer has different needs than one 54 weeks old. The main objective, therefore, the phase feeding is to reduce the waist of nutrients caused by feeding more then a bird actually needs under different sets of conditions.

A phase feeding program for laying hens generally calls for use of a rather high-protein feed (usually 17 to 18%) from the onset of egg production through the peek production period. Thereafter, a lower level o protein (about 16%) is fed for the next 5 or 6 months, followed by still lower levels (usually 15%) until the laying period is completed.

Do it yourself! An egg producer has a herd of ____ laying hens to which it is desired to feed a ____ % protein ration. Such grains are available:

1. _____ containing ____% protein;
2. _____ containing ____% protein;

A ____ % protein supplement, which is reinforced with minerals and vitamins, can be bought. What percent of the ration should constitute grains and what ____ % protein supplement? How much of each component is needed to make a monthly feed supply for this laying heard?

Lesson 17 . Broiler feeding. **Estimation profitability of broiler production**

Feed is the largest cost item in broiler production, representing 65 to 75% of the total costs. The present technologies of broiler production enable to reach 2,0-2,5 kg live weight at 42 days. Feeding the properly balanced complete rations, in which all of the nutrients needed by the bird are provided in the quantities necessary, is the key element of successful broiler production.

A phase feeding program for broilers requires using at least tow types of rations: starter and finisher. To enable high growth energy these rations should be of high energy density – a minimum of 12,6-13,0 MJ ME is required, which calls for use of oils or animal fats.

A starter should contain at least 22-23% of crude protein (CP) with proper amino acid supplementation: 1,2% lysine, 0,90% meth.+cys., 0,80% threonine and 0,20% thryptophan. A good example of a broiler corn and barley-based starter ration, where grains constitute 58% and the rest of the ration are protein-mineral-vitamin supplements of various origin, is given

in the table below (the ingredients have been priced by average market prices).

As is shown in the table, a good starter ration may cost 1,93 hrn/kg. A broiler with good growth energy may reach 600 g liveweight at 3 weeks age, showing 30-35g average daily gain and having consumed about 0,8 kg of complete starter ration.

A finisher has relatively lower protein level (18,0–18,5%) with correspondingly lower amino acid content: about 1,0% lysine, 0,82% meth.+cys., 0,74% threonine and about 0,17% thryptophan.

18.1 Starter ration for broilers (0-3 weeks)

<i>Ingredient</i>	<i>%</i>	<i>Price, UAH/kg</i>
Corn, %	48,0	
Barley,%	10,0	
Soybean meal (44% CP),%	19,5	
Soybean oil (or sunflower oil),%	6,0	
Fish meal (60-65% CP),%	14,1	
Methionine,%	0,1	
Dicalcium phosphate,%	0,7	
Limestone,%	0,4	
Salt,%	0,2	
Premixe (trace elements and vitamins),%	1,0	
Total	100	
Calculated values (per 1 kg diet)		
<i>Metabolizable energy, MJ</i>		<i>13,04</i>
<i>Crude Protein, %</i>		<i>23,09</i>
<i>Lysine, %</i>		<i>1,44</i>
<i>Calcium, %</i>		<i>1,16</i>
<i>Phosphorus, %</i>		<i>0,77</i>

It should be noted that crude fibre in both the starter and the finisher should not exceed 4%. A good example of a finisher, based on corn and barley, is given in the following table (table 18.2).

Grains constitute relatively larger proportion in finisher ration than in starter – 69% in the example above and 31% are provided with protein supplement, reinforced with minerals and vitamins. The cost of finisher in our example makes up 1,56 hrn/kg. On the average, a broiler consumes about 3 kg of complete ration during the finisher period, showing 80-90 g daily gain and reaching 2,2-2,3 kg liveweight. Thus, a food conversion ratio in broiler production should not exceed 1,6-1,8:1.

18.2 Finisher ration for broilers (4-6 weeks)

<i>Ingredient</i>	<i>Percentage</i>	<i>Price, UAH/kg</i>
Corn, %	47,0	
Barley,%	22,0	
Soybean meal (44% CP),%	15,0	
Soybean oil (or sunflower oil),%	5,0	
Fish meal (60-65% CP),%	8,4	
Methionine,%	0,1	
Dicalcium phosphate,%	0,8	
Limestone,%	0,4	
Salt,%	0,3	
Premixe (trace elements and vitamins),%	1,0	
Total	100	
<i>Calculated values (per 1 kg diet)</i>		
<i>Metabolizable energy, MJ</i>		<i>12,72</i>
<i>Crude Protein, %</i>		<i>18,69</i>
<i>Lysine, %</i>		<i>1,06</i>
<i>Calcium, %</i>		<i>0,93</i>
<i>Phosphorus, %</i>		<i>0,65</i>

The nutrient requirements of broilers are summarized in the following table.

18.3 Nutrient requirements of broilers (per 1 kg of complete ration)

Ingredient	Starter (0-3 weeks)	Finisher (4-6 weeks)
Metabolizable energy, MJ	13,0	12,6
Crude Protein, %	22,0-23,0	18,0-18,5
Crude fiber,%	<4,0	<4,0
Lysine,%	1,2	1,09
Methionine+Cystine,%	0,86	0,82
Threonine,%	0,81	0,74
Thryptophan,%	0,21	0,17
Ca,%	0,9-1,2	0,7-1,0
P,%	0,7	0,6
Na,%	0,14-0,25	0,12-0,25
Mn, mg	50	50
Zn, mg	50	50
Vitamin A, IU	8000	8000
Vitamin D, IU	1000	1000
Vitamin E, mg	15	15

Now we will try to estimate the profitability of broiler production,

using the rations listed above. Let's assume that a producer purchased 1000 daily chicks at 2 hrn per chick. The mortality percentage is 5%. Two-phase feeding system is being practiced and feed represents 70% of the total production costs. Finished broilers are being sold at 42 days with 2,2 kg live weight at the price of 10 hrn per 1 kg live weight. Procedure of profitability estimation is given in the following table.

18.4 Estimation of profitability of raising 1000 broilers

Item	Calculations	Sum, UAH
Purchase price of daily chicks	1000 chicks x ___ UAH/chick	
Cost of feeds:		
1. Starter	1000 chicks x 0,8 kg x ___ UAH/kg	
2. Finisher	1000 chicks x 3,0 kg x ___ UAH/kg	
Total feed costs	-	
Total production costs	_____ x 100% / 70%	
<i>Purchase price + Production costs</i>		
<i>Market price of finished broilers</i>	1000 chicks x 0,95 x 2,2 kg x ___ UAH /kg	
<i>Net profit</i>		
<i>Profitability, %</i>		

Conclusion: each batch of finished broilers will bring the producer 10009 hrn income and profitability of broiler production makes up 91,9%. How many cycles could be performed during the year? How to estimate the annual broiler production at the farm? These questions will be discussed in the next lesson.

Do it yourself! A broiler producer purchased _____ daily chicks at _____ hrn per head. Such grains are available:

1. _____ containing ___% protein (market price _____ hrn/kg);
2. _____ containing ___% protein (market price _____ hrn/kg);

A ___ % protein supplement, which is reinforced with minerals and vitamins, can be bought.

The mortality percentage is _____ %.

Finished broilers are being sold at 42 days with _____ kg live weight at the price of _____ hrn per 1 kg live weight.

What percent of the starter and finisher rations should constitute grains and what ___ % protein supplement? Calculate the total feed costs on the bases of 2-phase feeding program. Estimate the profitability of broiler production when feed constitutes _____ % of the total production costs.

Lesson 18. Technology of broiler production

No other segment of agriculture is as well suited to assembly-line production techniques as broiler production.

In modern commercial broiler production, the bird spends its entire life in one house; that is, it is not brooded in a special brooder house, and then moved to a house for growing, for broiler raising is basically a brooding operation. Instead, brooder houses are thoroughly cleaned and disinfected between flocks, preferably with the quarters left idle one to two weeks before starting a new group.

It provides for the orderly flow of hatching eggs, chicks, feed and other supplies necessary for the efficient production and supply of processed broilers into market channels. The success in broiler production is largely determined upon environmental factors, the most important of them are as follows:

✓ Housing.

The first requirement for growing broilers is adequate housing. Because broiler production is essentially a chick-brooding operation, the house should contain equipment so that such factors as temperature, moisture, air quality and light can be controlled easily. It should also provide for efficient installation and operation of brooding, feeding, watering and other equipment. All broiler companies require buildings with insulated roofs, side walls and end walls. Control over temperature, ventilation and air movement is necessary. Broiler houses should have planned air inlets, exhaust fans, heaters, an evaporative cooling system, thermostats and timers to provide environmental control.

✓ Feeding Equipment.

Mechanical feeders are a necessity. When properly installed and maintained, these feeders save labour and feed. Generally, two lines of pan-type feeders are installed. These are placed on winches with pulleys and cables so the entire system can be raised to the ceiling during catching and clean-out. If a controlled feeding program is used, pay special attention to bird density, feeder space, nutrient density and environmental conditions. The amount of time the birds are allowed to eat should increase with age. Bulk feed storage bins are also a necessary part of feeding equipment. The bins are located outside the house. An auger is used to move the feed from the bin into the house.

✓ Watering Equipment.

Water is an essential nutrient for broilers. It is used for heat removal, digestion and formation of body tissues. Broilers should consume approximately 1,5-2,0 times as much water as feed on weight basis. A

decrease in water consumption is known to substantially reduce feed consumption, which in turn can adversely affect feed conversion ratio. In the past, trough and cup waterers were the primary types of waterers used in broiler production. Currently, almost all broiler houses are equipped with nipple waterers. Nipple waterers provide several advantages over other types of waterers. They reduce water wastage, litter caking and keep water cleaner.

The **annual broiler production** of an enterprise depends upon available confinement capacity, bird density, number of cycles per year and mortality level.

Let's assume that a broiler producer has one confinement with standard dimensions 12 x 84 m and useful capacity (part of the total floor square taken by chicks) 880 m². If confinement will be filled with the daily chicks at the rate of 18 heads per 1 m² (bird density), then the building can accommodate 15840 daily chicks (880 x 18). Number of cycles per year

(N_{cycles}) could be estimated out of the following ratio:
$$N_{cycles} = \frac{365}{T_d + i},$$

where: T_d – length of growing-finishing period, days;
 i – sanitary interval, days.

If the growing-finishing period lasts 6 weeks (42 days) with sanitary interval 2 weeks (14 days), then 1 production cycle could be completed in 56 days.

Thus, in our example,
$$N_{cycles} = \frac{365}{42 + 14} = 6,5 \text{ cycles.}$$

With the mortality level of 5%, each batch of finished broilers will count on average 15048 heads per 1 cycle (15840 x 0,95). Then, the annual broiler production from this confinement makes up 97812 of finished broilers (15048 x 6,5) or 215186 kg in live weight (97812 heads x 2,2 kg/head).

If producer plans to produce, say, 1 million of broilers per year, he will need at least 10 confinements 12 x 84 m (1000000 : 97812).

If the enterprise has complete cycle, that is, produces its own eggs for incubation, and has facilities for meat processing then we need to estimate some additional parameters: size of the parent stock, number of incubators, and production capacity of meat processing line.

Using the example shown above, let's estimate these additional parameters for the broiler enterprise producing 1 million broilers with complete cycle.

Total number of batches of finished broilers at the enterprise with 10 confinements is: 6,5 cycles/confinement x 10 confinements = 65 cycles;

To estimate the number of incubation eggs ($N_{incub.egg}$), hatchability

percent (% *Hatch.*) should be counted for (the percentage of fertile eggs which actually hatch out as live young): $N_{incub.egg} = \frac{N_{dailychicks} \times 100\%}{\% Hatch.}$

If percent hatchability is 70%, then $N_{incub.egg} = \frac{15840 \times 100\%}{70\%} = 22629$ eggs.

Not all eggs produced by parent stock are suitable for hatching, it is determined by fertility percent (percentage of fertile eggs of all eggs produced). If fertility percent is 70%, then for each batch of daily chicks the parent stock should lay 32327 eggs (22629 / 0,70).

The total number of laid eggs needed to produce 65 batches of finished broilers is: 32327 x 65 = 2101255. And the total number of hatching eggs is: 22629 x 65 = 1470885.

To calculate the size of parent stock (number of hens and number of cocks), we need to know the average egg production per hen and the sex ratio (hens to cock ratio). If the average egg production is 180 eggs per layer, then we need 11674 “average” hens (2101255 : 180). The standard sex ratio for broiler production is 8:1. It means that the average cock number in the flock should constitute 1459 heads. If the culling rate in the heard is 30%, then to provide the necessary average figures we should increase the estimated flock numbers by 1,43 (this figure is called the heard “turn over factor” and could be estimated by dividing 100 by (100 - Culling rate): 100/(100-30)=100/70=1,43). Thus, the parent stock of the enterprise at the beginning of the year will consist of 16694 hens (11674 x 1,43) and 2086 cocks (1459 x 1,43) or 18780 heads in total.

To determine the number of incubators needed to hatch all the 1470885 of hatching eggs we should estimate the number of hatching cycles per year. It depends upon the type of incubator. Let’s use incubator “Universal-55” with capacity of 56784 hen eggs. Its specifications provide for 30 days of sanitary period and 20 days needed for loading all the sections. Thus, each incubator will be in hatching only 315 days of the year (365-50). Whereas the length of incubation period for hens is 22 days, the number of cycles per incubator is 315 : 22 = 14,3. The annual hatching capacity of one incubator makes up 812011 eggs (56784 x 14,3). To incubate 1470885 eggs we need 2 incubators (1470885 : 812011). This figure should be increased by 15% (reserve fund), that is 2,3 (2 x 1,15) ≈ 2,0 incubators “Universal-55” – this is the adequate number of incubators for the enterprise.

The final step of calculations is the estimation of productive parameters of meat processing unit. Dividing the annual number of finished broilers (1 million) by 255 (number of working days per year), we estimate

the daily production of processing unit: $1000000 : 255 = 3922$ heads. If processing unit works in one shift and the working day lasts 8 hours, we could assume that processing line will be working 6,5 hours per day (the rest of the time is needed for loading and reloading the line, cleaning the equipment etc.). Thus, the number of broilers, processed per hour, makes up 603 heads. The last figure estimates the production capacity of processing line.

Do it yourself! Calculate the annual broiler production from one confinement with useful capacity _____ m² and bird density _____ heads/m². Estimate the number of confinements needed for production of _____ broilers per year. Using the data from the previous lesson, estimate the total feed budget of a broiler enterprise.

Do it yourself! Basing upon results obtained in calculations above and the standard figures used in the lesson, estimate additional parameters needed to make a complete cycle enterprise: size of the parent stock, number of incubators, and productive capacity of meat processing line.

Lesson 19. Wool production and grading

Wool is a fine soft wavy hair from the fleece of sheep. Hair or wool fiber grows from a **follicle** located in the outer layers of the skin. Growth occurs at the base of the follicle, where there is a supply of blood, and cells produced are pushed outward. The cells die after they are removed from the blood supply because they can no longer obtain nutrients or eliminate wastes. A schematic drawing of a wool follicle is presented in Figure 20.1.

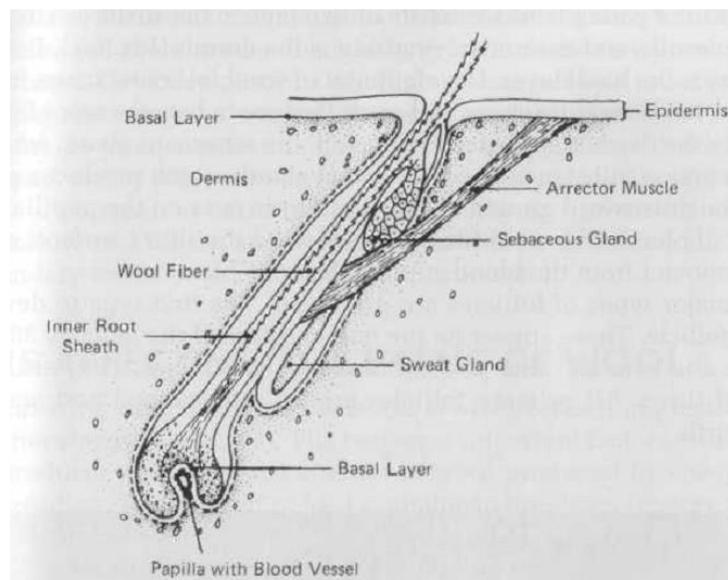


Figure 20.1 Schematic drawing of a wool follicle.

The **cuticle** causes the fibers to cling together. The intermingling of wool fibers is known as **felting**. The felting of wool is advantageous in that wool fibers can be entangled to make woolens, but it is also responsible for the shrinkage that occurs when wool becomes wet.

All wool and hair fibers have a similar gross structure, consisting of an outer thin layer (cuticle) and a cortex that surrounds an inner core (**medulla**) in medullated fibers (Fig. 20.2). Only medium and coarse wools have a medulla. It is absent in fine wools.

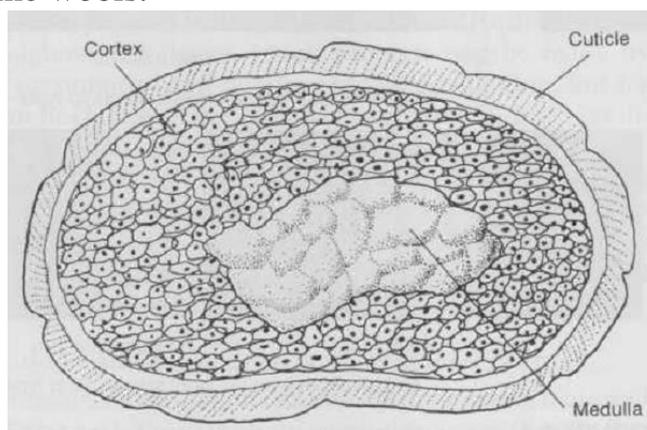


Figure 20.2 Cross section of a medullated wool fiber.

The chief fleece characteristics of interest and importance to both the producer and manufacturer are:

1. Grease – in a broad sense, grease refers to all the impurities found in unscoured wool, including the yolk, suint, and soluble foreign matter but not the vegetable matter. Shrinkage of fleece varies widely – from 30 to 75%, with many factors affecting it. Clean weight of fleece, taken as a percentage to grease weight, characterises yield of clean fleece:

$$\text{Yield} = \frac{\text{Clean weight}}{\text{Grease weight}} \times 100\% ;$$

2. Length – together with quality, length constitutes the principal basis of classification and grading in buying and selling (see the table 20.1) and largely determines the use to which wool will be put;

3. Density – density refers to the closeness or compactness of the fibres in the fleece and is often defined as a number of fibres per unit area of skin;

4. Diameter – wool sorting is based on fineness of fibre, and this is considered to be the soundest basis on which wool and top qualities can be classified (see the table 20.1). In judging sheep, **the number of crimps** is usually accepted as an index of fineness: while the diameter of wool fibres varies anywhere from 17 to 50 microns the number of crimps is ranging from 2 to 1 per cm.

Wool grading is based primarily on fibre diameter or fineness, but consideration is also given to length. Wool can be separated roughly, after a little experience, into three broad market grades according to its diameter: 1) fine wool; 2) medium wool; 3) coarse wool. There are 2 main methods of grading wool according to diameter with several grades in each: the *numerical count system (worsted spinning count)* and the *micron system*.

The **numerical count system** divides all wool into 14 grades, and each grade is designated by a number. The numbers range from 80s for the finest wool down to 36 for the coarsest.

Theoretically, the numerical count system is based on the number of hanks of yarn (each hank representing 512 m), that can be spun from one pound of such wool. Spinning count is determined greatly by the diameter: the finer the wool, the more hanks could be spun of it.

20.1 Comparative wool grades and classes

Type of wool	Standard specifications		Length classes, over (cm)
	Numerical count grade	Micron system, (microns)	
Fine	Finer than 80s	Under 17,70	-
	80s	17,70-19,14	6,99
	70s	19,15-20,59	6,99
	64s	20,60-22,04	6,99
Medium	62s	22,05-23,49	7,62
	60s	23,50-24,94	7,62
	58s	24,95-26,39	8,26
	56s	26,40-27,84	8,26
	54s	27,85-29,29	8,89
	50s	29,30-30,99	8,89
Coarse	48s	31,00 - 32,69	10,16
	46s	32,70-34,39	10,16
	44s	34,40-36,19	12,70
Very coarse	40s	36,20-38,09	12,70
	36s	38,10-40,20	12,70
	Coarser than 36s	Over 40,20	-

The **micron system** is a substantially more technical and accurate measurement of the wool fibre. Sixteen grades are used, and are based on the average fibre thickness as measured by a micrometer. An 80s wool, for example, averages about 18 microns, which is less than half a 36s wool that averages 39 microns.

Shearing. Up to and during the early part of the 1900s, most shearing was done by hand shears. Then clippers, similar to barber's

clippers, were developed; hand-powered at first, then electrically powered. A skilled shearer can clip 200 or more sheep per day using electric clippers.

Factors affecting the value of wool

Ensuring wool quality is the result of best production practices both before and after shearing. The two most important factors under the control of the producer that affect the amount of wool produced by sheep are nutrition and breeding. The amount of feed available to the sheep (energy intake) and the percentage of protein in the diet influence wool production. Wool production is decreased when sheep are fed diets having less than 8% protein. When the diet contains more than 8% protein, the amount of energy consumed is the determining factor in wool production.

Improving wool production per animal through breeding involves selection for increased clean fleece weight, staple length, fineness and uniformity of length, and fineness throughout the fleece. Much progress can be made by performance-testing rams for quantity and quality of wool production, but for overall improvement of the flock, both lamb and wool production must be included.

Sheep and Angora goat producers are interested in maximizing net income from their sheep and goat operations. Increasing net income from wool and mohair can be accomplished by selecting to improve wool and mohair production and grade. The values of wool and mohair that are produced can be enhanced by giving attention to the following items.

1. Sheep or goats should be shorn when the wool or mohair is dry.
2. Inferior portions of the fleece should be removed at the skirting table and sacked separately. Offsorts (inferior portions) include parts of the clip that are matted or heavily contaminated with dung or vegetable matter, bellies, topknots, and floor sweepings (Fig. 20.2).
3. Wool or mohair should be sacked by wool grades so that when **core samples** are taken from a sack of otherwise good wool, a few fleeces of low-grade wool (or mohair) will not cause the entire sack of wool or mohair to be placed in a low grade.
4. Wool should be shorn with few double clips.
5. Fleeces should be tied with paper twine after they are properly folded with the clipped side out.
6. A **lanolin-based** paint should be used for branding animals. This type of paint is scourable.
7. Fleeces from black-faced sheep should be packed separately from other wool, as should black fleeces. Black fibers do not take on light-colored dyes and consequently stand out in a garment made from black and

white fibers dyed a light pastel color.

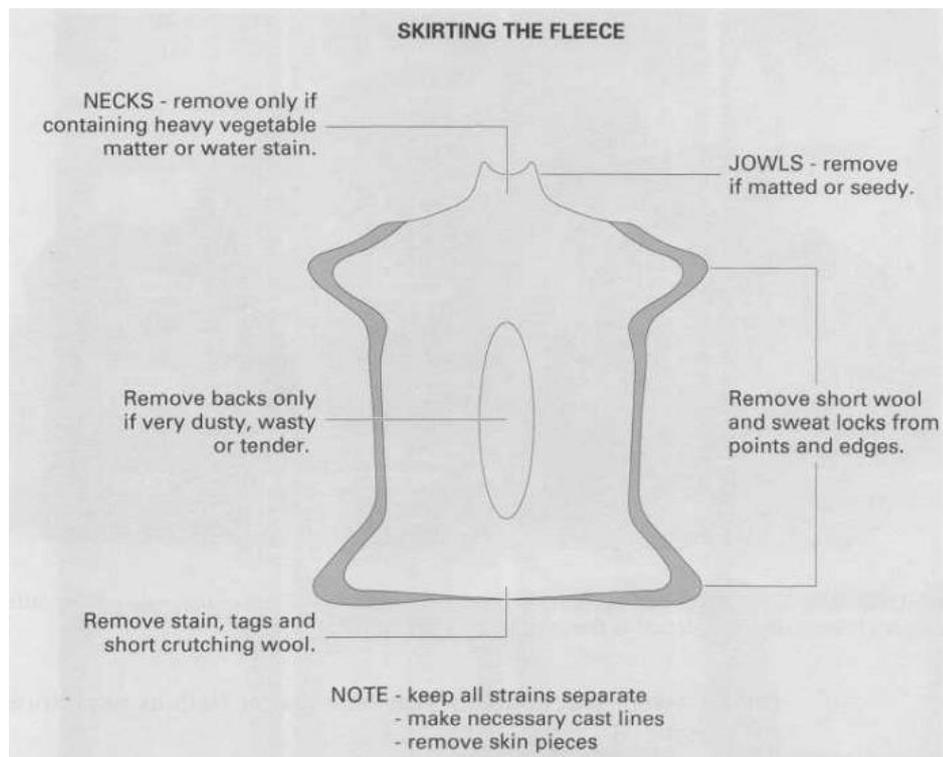


Figure 20.2 Skirting the fleece.

8. All tags, sweepings, and wool or mohair from dead animals should be packed separately.

9. Hay that has been baled with twine should be carefully fed to sheep; otherwise, pieces of twine will get into the wool or mohair and markedly lower its value.

10. Environmental stresses should be avoided. Being without feed or water for several days or having a high fever can cause a break or weak zone in the wool fibers.

11. Wool containing coarse fibers, or kemp, should be avoided, or kempy fleeces should be packed separately. Cloth and wool containing these coarse fibers are highly objectionable and thus are low in price.

Undesirable fleeces have a lower value than fleeces containing white fibers and minimal foreign material:

Burry - wool that contains vegetable matter, such as grass seeds and prickly seeds, which adheres tenaciously to wool.

Chaffy - wool that contains vegetable matter such as hay, straw, and other plant material

Cotted - wool fibers that are matted or entangled

Dead - wool pulled from sheep that have died but that have not been slaughtered

Murrain - wool obtained from decomposed sheep

Do it yourself! A wool producer has a heard of _____ sheep. After shearing he gained _____ kg of wool in grease weight, including _____ kg wool of the _____ quality and _____ kg wool of the _____ quality. The yield of clean fleece, estimated at the manufacture plant, made up _____ %.

Calculate the average wool production per 1 sheep in grease and clean weight. Estimate the total income, income per 1 sheep of the producer and profitability of wool production if the purchased prices for clean fleece are: _____ UAH/kg for the _____ quality fleece, and _____ UAH/kg for the _____ quality fleece, and the annual cost of keeping one sheep is _____ UAH (feeding, breeding costs, equipment etc).

Appendix 1

Energy values and composition of feeds (as-fed basis)

Feed name	Feeds characteristics									
	Oat feed units kg	ME _{cattle} , MJ	ME _{swine} , MJ	ME _{poultry} , MJ	NE _{lact} MJ	Dry matter, g	CP, g	CF, g	Ca, g	P, g
1	2	3	4	5	6	7	8	9	10	11
Hay										
Alfalfa	0,44	6,72	6,23	-	4,16	860	145	253	16	2,1
Grass	0,46	6,3	-	-	4,89	830	37	253	5,4	1,1
Clover	0,52	7,23	6,94	-	4,21	830	78	244	9,2	2,2
Straw										
Wheat	0,20	4,76	-	-	2,98	846	5	364	2,8	0,8
Barley	0,34	5,71	4,28	-	3,24	830	13	331	3,3	0,8
Grassmeal										
Alfalfa	0,72	8,62	7,73	5,78	4,46	900	119	211	17,3	3,0
Clover	0,71	8,41	7,98	4,66	5,13	900	94	207	14,0	2,9
Beets and tubers										
Fodder beet	0,12	1,65	1,74	0,99	0,84	120	9	9	0,4	0,5
Sugar beet	0,24	2,84	2,63	1,27	1,13	230	7	14	0,5	0,5
Potato	0,30	2,82	3,19	3,50	2,43	220	10	8	0,2	0,5
Silages and haylages										
Corn silage, 30% DM	0,20	2,52	1,70	-	1,44	300	23	73	0,8	0,6
Corn silage, 32% DM	0,24	3,47	2,65	-	2,09	320	27,5	56,3	0,8	0,2
Corn silage, 35% DM	0,30	3,81	2,65	-	2,31	350	30	68	0,75	0,55
Clover haylage	0,35	4,34	3,15	-	2,55	450	33	143	5,5	0,6
Alfalfa haylage	0,35	4,02	2,84	-	2,33	450	71	127	10,9	1,0
Beet pulp	0,12	1,13	1,74	0,39	0,88	112	6	33	1,5	0,14
Plant processing by products										
Wheat brans	0,75	8,9	9,3	6,67	5,17	850	97	88	2,0	9,6
Sunflower cake	1,08	11,0	10,1	7,42	6,30	900	250	129	5,9	12,9
Sunflower meal	1,03	10,41	11,46	7,78	6,34	900	384	144	3,6	12,2
Soybean meal 44% CP	1,21	11,97	12,97	8,89	7,51	870	440	62	2,7	6,1
Soybean meal 48% CP	1,21	12,12	14,17	9,62	7,60	870	480	32	2,8	6,6
Grains										
Wheat	1,27	10,8	13,7	12,71	7,39	870	142	28	0,7	4,3
Corn	1,33	12,20	13,7	13,43	7,32	870	94	38	0,3	2,8
Peas	1,18	11,1	13,6	11,53	7,41	870	192	54	2,0	4,3
Barley	1,15	10,5	12,7	10,57	6,91	870	85	49	2,0	3,9

1	2	3	4	5	6	7	8	9	10	11
Oats	1,00	10,14	11,14	9,88	6,16	870	108	101	1,0	3,0
Feeds of animal origin										
Meat and bone meal	1,04	8,34	9,02	9,66	5,08	950	450	-	154,4	74,4
Fish meal	1,31	11,9	14,03	12,36	7,38	900	620	-	42,8	25,4
Skimmed milk	0,1	1,2	1,37	1,04	0,77	86	32	-	1,2	0,9
Fresh milk	0,33	2,54	2,99	2,37	1,64	134,0	35	-	1,2	1,0
Other products										
Soybean oil	-	30,55	35,46	34,28	19,8	999,0	-	-	-	-

Appendix 2

Mineral supplements composition, %

Feed name	Ca	P	Na	N
Limestone	32,7	0,1	-	-
Diammonium phosphate	-	23		20
Bone meal	31,6	14,6	-	-
Calcium carbonate	39,2	-	-	-
Ammonium phosphate, monobasic	-	25	-	12
Monocalcium phosphate,	17,4	23	-	-
Sodium phosphate, monobasic	-	24	11	-
Dicalcium phosphate	23	17	-	-
Salt	-	-	39	-
Calcium phosphate, tribasic	34	18	-	-
Eggshell	33,9	0,2	-	-

Appendix 3

Gestation table (the average in-calf period lasts for 280 days)

Date bred	Calving date						
<i>January</i>	<i>October</i>	<i>April</i>	<i>January</i>	<i>July</i>	<i>April</i>	<i>October</i>	<i>July</i>
1	7	1	5	1	6	1	7
5	11	5	9	5	10	5	11
10	16	10	14	10	15	10	16
15	21	15	19	15	20	15	21
20	26	20	24	20	25	20	26
25	31	25	29	25	30	25	31
<i>February</i>	<i>November</i>	<i>May</i>	<i>February</i>	<i>August</i>	<i>May</i>	<i>November</i>	<i>August</i>
1	7	1	4	1	7	1	7
5	11	5	8	5	11	5	11
10	16	10	13	10	16	10	10
15	21	15	18	15	21	15	21
20	26	20	23	20	26	20	26
25	1 December	25	28	25	31	25	31
<i>March</i>	<i>December</i>	<i>June</i>	<i>March</i>	<i>September</i>	<i>June</i>	<i>December</i>	<i>September</i>
1	5	1	7	1	7	1	6
5	9	5	11	5	11	5	10
10	14	10	16	10	16	10	15
15	19	15	21	15	21	15	20
20	24	20	26	20	26	20	25
25	29	25	31	25	1 July	25	30

Daily yields changes during lactation

Lactation month										305 day
1	2	3	4	5	6	7	8	9	10	yield
11,4	11,4	10,6	9,7	9,0	8,2	7,4	6,5	5,3	3,9	2500
12,2	12,2	11,4	10,5	9,6	8,9	8,0	7,0	5,9	4,3	2700
13,5	13,5	12,5	11,6	10,7	9,8	8,9	7,8	6,6	5,1	3000
13,9	13,9	12,9	11,9	11,0	10,1	9,2	8,1	6,9	5,3	3100
14,4	14,4	13,3	12,3	11,3	10,4	9,5	8,4	7,1	5,5	3200
15,2	15,2	14,1	13,1	12,0	11,1	10,1	8,9	7,6	6,0	3300
15,6	15,6	14,5	13,4	12,3	11,4	10,4	9,0	7,9	6,2	3500
16,5	16,5	15,3	14,2	13,0	12,0	11,0	9,8	8,4	6,7	3700
17,8	17,8	16,5	15,3	14,1	13,0	11,8	10,6	9,2	7,4	4000
18,2	18,2	16,9	15,6	14,4	13,3	12,1	10,9	9,4	7,7	4100
18,6	18,6	17,3	16,0	14,8	13,6	12,4	11,1	9,7	7,9	4200
19,0	19,0	17,7	16,4	15,1	13,9	12,7	11,4	9,9	8,1	4300
19,9	19,9	18,5	17,1	15,8	14,6	13,3	12,0	10,4	8,6	4500
20,7	20,7	19,3	18,8	16,5	15,2	13,9	12,5	10,9	9,1	4700
22,0	22,0	20,4	18,9	17,5	16,2	14,8	13,3	11,7	9,8	5000
22,4	22,4	20,8	19,3	17,8	16,5	15,1	13,6	12,0	10,0	5100
22,8	22,8	21,2	19,7	18,2	16,8	15,4	13,9	12,2	10,3	5200
23,3	23,3	21,6	20,0	18,5	17,1	15,7	14,2	12,5	10,5	5300
24,1	24,1	22,4	20,8	19,2	17,7	16,3	14,7	13,8	11,0	5500
25,0	25,0	23,2	21,5	19,9	18,4	16,9	15,3	13,5	11,5	5700
26,2	26,2	24,4	22,6	20,9	19,3	17,8	16,1	14,3	12,2	6000
28,4	28,4	26,4	24,4	22,6	20,9	19,2	17,4	15,6	13,4	6500
30,5	30,5	28,3	26,3	24,3	22,5	20,7	18,8	16,8	14,6	7000

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