Problems of Breeding and Rearing in High-Performance Dairy Cattle Herds

Modul no. 4: Precision livestock farming

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Erasmus+ project 2021-1-SK01-KA220-HED-000032068

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Problems of Breeding and Rearing in High-Performance Dairy Cattle Herds

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Lecture plan

Problem 1: Increasing milk yield, worsening reproductive performance, and decreasing cow longevity.

Problem 2: Lengthening of the milk production period (lactation).

Problem 3: Mastitis and its negative impact on milk production yield and milk composition.

Problem 4: Difficulties in balancing feed rations – the occurrence of excessive amounts of urea in milk.

Problem 5: Consequences of negative energy balance in dairy cows. Ketosis and the presence of ketone bodies in cow milk.

Problem 6: Moving away from the quota system for milk production and transitioning to a free-market system.

Problem 7: Optimization of the chemical composition of milk and further improvement of its hygienic quality.

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Problem 1 ☞

☞ Increasing milk yield, worsening reproductive performance, and decreasing cow longevity.

Changes in Average Milk Yield (kg) per 305-Day Lactation and Length of the Intercalving Period (days) of Cows Evaluated in Poland from 1980 to 2023*

Estimation year	Number of estimatead cows	Milk yield /kg/	Length of intercalving period /days/
1980	1058478	3297	389
⋮	⋮	⋮	⋮
2000	387645	5379	400
⋮	⋮	⋮	⋮
2005	511464	6508	416
⋮	⋮	⋮	⋮
2010	598402	6980	432
⋮	⋮	⋮	⋮
2015	753 613	7771	432
⋮	⋮	⋮	⋮
2020	797423	8823	430
⋮	⋮	⋮	⋮
2023	807 719	9 150 kg	420

+5853

+31

*- Data from the Polish Federation of Cattle Breeders and Milk Producers.

In the last 43 years in Poland, an increase in milk yield during a 305-day lactation by every 189 kg has corresponded to a lengthening of the intercalving period by 1 day.

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Problem 1 ☞ ☞ **Increasing milk yield, worsening reproductive performance, and decreasing cow longevity.**

Longevity is a socio-biological phenomenon describing an **ability of an individual to survive beyond** the species-specific average age of death*.

Lifespan for Artiodactyla species varied between **11.1 to 39.4 years***.

The **natural lifespan of cows is approximately 20 years**, but the average culled time is much earlier than the natural life.

Actually longevity defined as the age of cows at culling was **5.87 years** in Netherlands (2021)**, average longevity milking cows in US is about **5 years** (2023)***, average longevity cows in Poland was **5.74 years** (2009)****.

- - Shilovsky, G.A., Putyatina, T.S. & Markov, A.V. Evolution of Longevity as a Species-Specific Trait in Mammals. Biochemistry Moscow 87, 1579–1599 (2022).

** - Vredenberg I, Han R, Mourits M, Hogeveen H and Steeneveld W (2021 An Empirical Analysis on the Longevity of Dairy Cows in Relation to Economic Herd Performance. Front. Vet. Sci. 8:646672

*** - Hanson M., 2023: Is it Time to Rethink Dairy Cow Lifespan? Dairy Herd Management, 8.

****-Sawa, A., Bogucki, M., 2009. Długowieczność krów i przyczyny ich brakowania. ANIMAL SCIENCE AND GENETICS, vol. 05, no. 2, pp. 55-62.

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Problem 2 ☞ **Lengthening of the milk production period (lactation).**

MILK PRODUCTION SYSTEMS IN THE COUNTRY *

– THE ISSUE OF EXTENDED LACTATIONS

In the **TRADITIONAL PRODUCTION SYSTEM**, the standard length of lactation for cows is 305 days, or 10 months. The annual production period for cows includes two main phases:

- **Lactation period** – 305 days
- **Dry period** – 60 days

In the **TRADITIONAL PRODUCTION SYSTEM**, a cow should calve at **least once in a calendar year**.

In practice, a **PRODUCTION SYSTEM WITH EXTENDED LACTATIONS** is becoming increasingly common. In this system, the average length of lactation in the country is extended to 390 days.

In the **EXTENDED LACTATION SYSTEM,** dairy cows calve not once every 12 months as in the traditional system, but approximately every 18 months. This involves replacing three 12-month production cycles with two 18-month cycles.

Currently, 60% of cows in the country are producing milk in this system.

*- Guliński P., 2017: Bydło domowe hodowla i użytkowanie. Wydawnictwo Naukowe PWN Warszawa.

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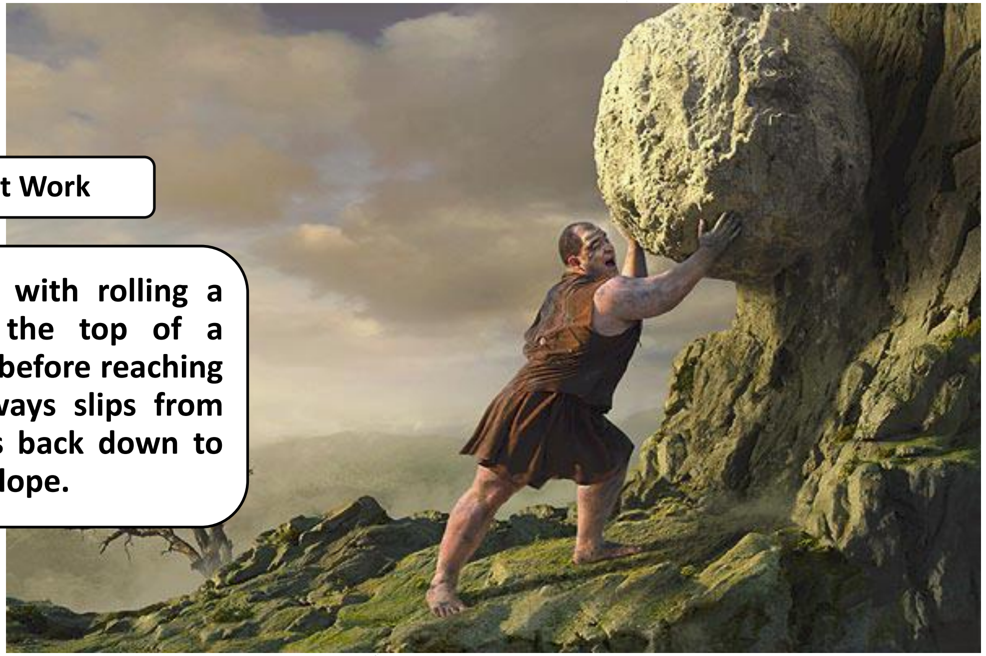
Problem 3 ☞

- ***Mastitis* and its negative impact on milk production yield and milk composition.**

Caring for high hygienic and cytological quality of milk obtained from cows is a daily challenge for cattle breeders both in the country and worldwide.
It can be compared to **„Sisyphean labor"** - signifying hard, monotonous, persistent work that never fully achieves complete success.

Sisyphus at Work

Sisyphus is tasked with rolling a large boulder to the top of a mountain, but just before reaching the summit, it always slips from his hands and rolls back down to the bottom of the slope.



Sisyphus is a symbol of human heroism and perseverance.

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Problem 3 ☞ • *Mastitis* and its negative impact on milk production yield and milk composition.

- Somatic cells are the primary criterion for assessing the health status of mammary glands and the cytological quality of milk.
- Their number is commonly regarded as a measure of udder health in dairy cows.
- In Poland and the European Union, milk collection occurs with somatic cell counts of <400,000/ml; in the USA, it is <750,000/ml.
- An increase in somatic cell count is accompanied by a decrease in milk production (up to 12% in subclinical cases) and unfavorable changes in the chemical composition of milk.
- Economic losses on a national scale amount to approximately 1 billion PLN annually.
- Research results indicate that in Poland, at least 30-40% of cows experience mastitis (clinical and subclinical) at least once during lactation.
- It is generally accepted that 25% of all culled cows are due to mastitis.

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Problem 4 ☞ **Difficulties in balancing feed rations – the occurrence of excessive amounts of urea in milk.**

The presence of urea in cow milk is a result of the processes occurring in the digestive tract, which lead to an excess of undigested ammonia in the body due to microorganisms.

This highly toxic chemical compound is detoxified in the liver and converted into urea.

The main reason for the excessive level of urea in milk is an excess of protein in the feed rations and their unbalanced energy-to-protein ratio.

* - Guliński P., Salamończyk E., Młynek K., 2016: Improving nitrogen use efficiency of dairy cows in relation to urea in milk - A review. Animals Papers and Reports, 34(1), 5-24.

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Problem 4

Difficulties in balancing feed rations – the occurrence of excessive amounts of urea in milk.

Factors influencing the level of urea in milk also include:

- the frequency of feeding,
- the number of milkings and the length of the intervals between milkings,
- the body weight of the cows,
- the amount of water intake,
- the level of Na and K supplementation in feed rations,
- the pH of the rumen.

Information about the concentration of urea nitrogen in milk from dairy cows allows breeders to*:

- assess the energy-to-protein balance of the feed rations,
- reduce feed costs,
- and contribute to the reduction of nitrogen (N) emissions in the environment.

* - Guliński P., Salamończyk E., Młynek K., 2016: Improving nitrogen use efficiency of dairy cows in relation to urea in milk - A review. Animals Papers and Reports, 34(1), 5-24.

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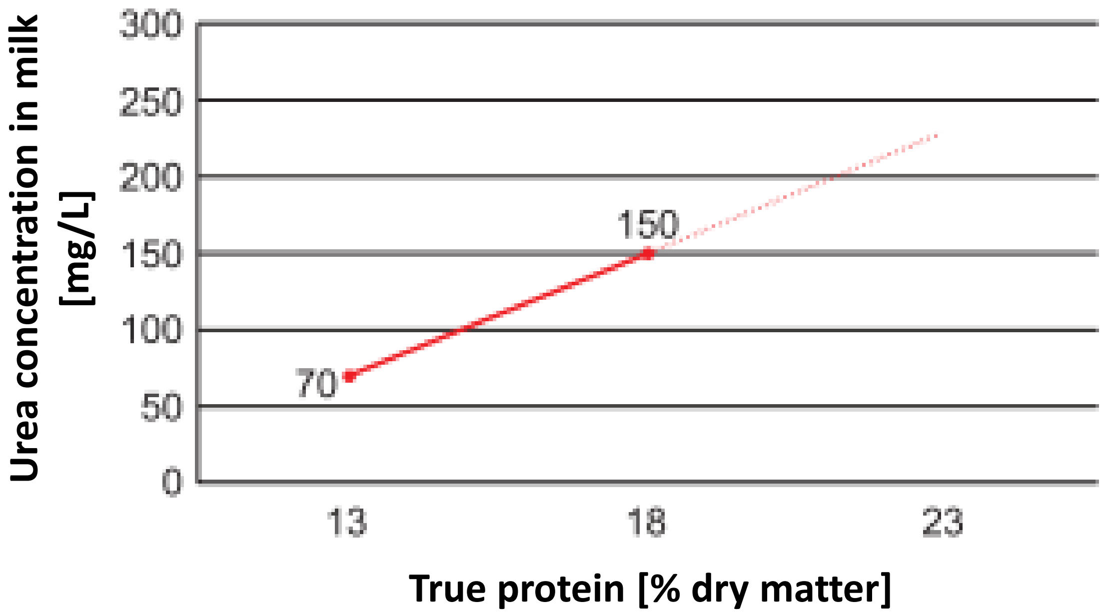
Problem 4

Difficulties in balancing feed rations – the occurrence of excessive amounts of urea in milk.

The relationship between the protein level in feed and the concentration of urea in cow milk (Jonker et al., 1999; Kebreab et al., 2002)



An increase in the proportion of true protein in the dry matter of the feed from 13% to 18% leads to an increase in the concentration of urea in cow milk from 70 to over 150 mg per liter.

Jonker, J.S., Kohn, R.A., Erdman, R.A., 1999: Milk urea nitrogen target concentrations for lactating dairy cows fed according to National Research Council recommendations. Journal of Dairy Science, 82 (6), 261-1273

Kebreab, E., France, J., Mills, J.A., Allison, R., Dijkstra, J., 2002: A dynamic model of N metabolism in the lactating dairy cow and an assessment of impact of N excretion on the environment.Journal of Animal Science, 80 (1), 248-259

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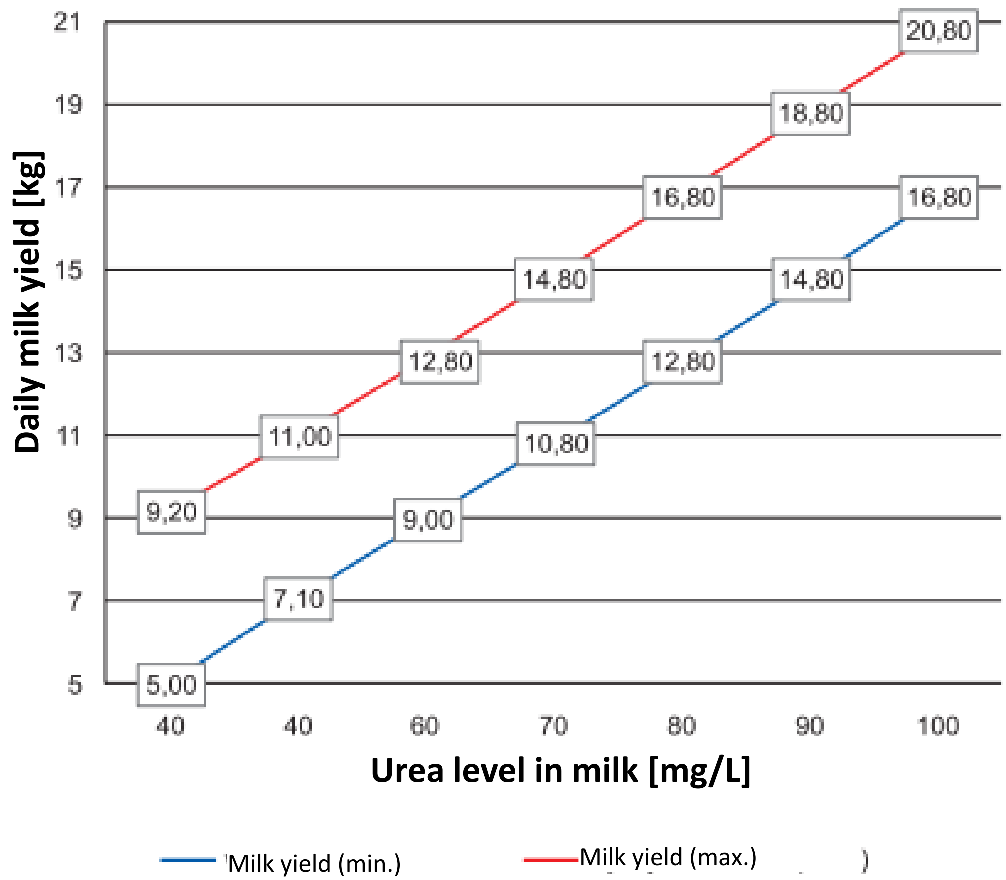
Problem 4

Difficulties in balancing feed rations – the occurrence of excessive amounts of urea in milk.

Optimal urea concentration in milk from cows with varying daily milk yields (Jonker et al., 1999)



Jonker, J.S., Kohn, R.A., Erdman, R.A., 1999: Milk urea nitrogen target concentrations for lactating dairy cows fed according to National Research Council recommendations. Journal of Dairy Science, 82 (6), 261-1273

Problem 4

Difficulties in balancing feed rations – the occurrence of excessive amounts of urea in milk.

Final effect of urea content analysis in a dairy cattle herd

Practical use of information about urea concentration in milk

Group I (urea < 150); Group II (urea > 250); Group III (protein < 3,2); Group IV (protein > 3,6)

Protein percent In milk	Urea level in milk (mg/L)		
	< 150	150-250	> 250
< 3,2	**Protein** and energy **deficiency**	Energy deficiency	**Protein surplus** and energy deficiency
3,2 – 3,6	**Protein deficiency** and slight energy surplus	**Balanced level of protein and energy**	**Protein** surplus and slight energy deficiency
> 3,6	**Protein deficiency** and excess energy	Energy surplus	**Protein and energy surplus**

In the country:
56.3% of milk samples meet the protein requirement balance criteria
35.0% of milk samples meet the energy requirement balance criteria

*-Guliński P., 2023: The effect of different content of protein and urea in milk, as biomarkers of energy-protein balance of food rations, on the level of selected milk performance characteristics of polish holstein-friesian cows . Acta Scientiarum Polonorum, 22(2), 17-30.

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Problem 4 ☞

Difficulties in balancing feed rations – the occurrence of excessive amounts of urea in milk.

Reducing nitrogen excreted by dairy cattle is desirable due to concerns about the agricultural contribution to environmental pollution with nitrogen compounds (N_2O, NO, and NO_2), particularly regarding the release of ammonia into the atmosphere and the leaching of nitrates into surface and groundwater.

The primary source of ammonia is the nitrogen contained in the urea of manure and animal urine, which hydrolyzes into ammonia and carbon dioxide.

A properly fed cow emits approximately 40 kg of ammonia into the atmosphere each year.

It is estimated that in Poland, the annual ammonia emission is around 386,000 tons, with cattle emitting approximately 155,000 tons into the atmosphere.

Problem 4 ☞ **Difficulties in balancing feed rations – the occurrence of excessive amounts of urea in milk.**

The impact of urea levels in milk from cows on ammonia emissions to the atmosphere during a single lactation period (kg per cow) (Guliński and Salamończyk, 2023*)

Factor	Observation number	Urea in urine (kg)	Ammonia from urea (kg)
Urea in milk (mg/L)			
1-150	168	56,9	32,3
150-250	701	76,6	43,5
>250	220	101,5	57,7
Total/average	1089	98,6	44,6

* - Guliński P., Salamończyk E., 2023: Evaluation of lactational excretion of urea and ammonia in dairy cattle herds. Animals Science and Genetics, 19(1), 69-82.

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Problem 4 ☞

Difficulties in balancing feed rations – the occurrence of excessive amounts of urea in milk.

Can cow toilets in the Netherlands solve the problem of ammonia emissions from dairy cattle farms?

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Problem 5

Consequences of negative energy balance in dairy cows. Ketosis and the presence of ketone bodies in cow milk.

In the bodies of high-yielding dairy cows, there is an energy deficit during the first 8-10 weeks of lactation*.

Animal bodies, in an effort to reduce this deficit, mobilize energy reserves stored as body fat.

As a result, the level of fatty acids in the blood of cows increases up to 10 times, which contributes to a decrease in appetite and the amount of feed consumed by the cows, especially the carbohydrates contained in it.

Carbohydrates are an essential component in the process of burning fats. In energy metabolism, there is an unyielding principle: "fats burn in the fire of carbohydrates„

In situations of insufficient carbohydrate (glucose) levels in the blood, there is incomplete burning of free fatty acids, leading to the presence of so-called ketone bodies in the blood, urine, and milk of cows.

* - Guliński P., 2021: Ketone bodies – causes and effects of their increased presence in cows' body fluids: A review, Veterinary World, 14(6): 1492-1503.

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Problem 5 ☞

Consequences of negative energy balance in dairy cows. Ketosis and the presence of ketone bodies in cow milk.

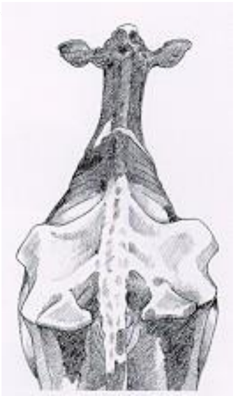
Decline in condition in cows

If the energy intake from feed is less than the energy expenditure associated with milk production, cows utilize their stored subcutaneous fat reserves to cover the energy deficit.

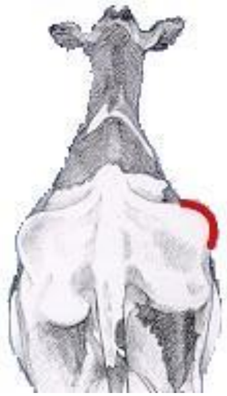
In a cow that had a condition score of 3.5 at the time of calving, there is a decrease in body weight of about 0.5-1 kg per day during the first 60-80 days of lactation.

1 kg of body fat covers the requirement for the production of 7.1 kg of milk. Thus, a loss of 70 kg of body fat in an adult cow is converted into nearly 500 kg of milk, exceeding the production guaranteed by the energy obtained from the feed consumed.

Condition „2" – thin

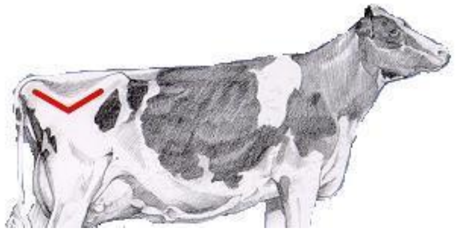


Condition „3" – optimal



Condtition „4" – fat

Condition ≤ „3"



Condition > „3"

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Problem 5

Consequences of negative energy balance in dairy cows. Ketosis and the presence of ketone bodies in cow milk.

Ketosis is one of the most important metabolic diseases in dairy cattle herds, including in our country.

It is a typical "occupational disease" of high-yielding dairy cows.

Ketosis leads to a significant decrease in milk production and adversely affects reproductive performance as well as the cows' resistance to infectious diseases, such as mastitis and endometritis.

The primary symptoms of ketosis include an atypical increase in milk fat content (above 5%) accompanied by a decrease in protein levels (below 2.9%).

The fat-to-protein ratio is elevated to a level exceeding 1:1.4.

Ketosis occurs in an average of 7 to 14% of the total number of cows in a herd; in high-producing herds, the percentage of cows affected by this condition can be as high as 50%.

Guliński P., 2021: Ketone bodies – causes and effects of their increased presence in cows' body fluids: A review, Veterinary World, 14(6): 1492-1503.

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Problem 6 ☞

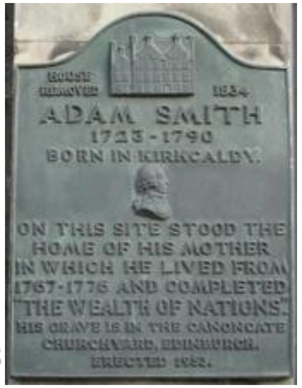
Moving away from the quota system for milk production and transitioning to a free-market system.

Since the Great Bourgeois Revolution in France and the overthrow of the feudal system (1789), a capitalist system regulating socio-economic relations has emerged worldwide.

Capitalist socio-economic relations are based on three fundamental principles of conducting economic activity, namely:

- **private ownership of the means of production,**
- **profit maximization,**
- **market competition as a method for determining the level of production and its price.**

*** - Adam Smith (1723-1790)-** the creator of the theoretical foundations of capitalism



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Problem 6

Moving away from the quota system for milk production and transitioning to a free-market system.

As is well known, the European Union, in terms of milk production, has excluded competition as a method for determining milk production levels since 1984, under the Common Agricultural Policy, by introducing administrative restrictions, such as a quota system.

This system was in place until March 2015 in EU countries, with the last quota year being 2014/2015, after which the milk market was opened to market mechanisms.

What does this mean for the dairy sector in the country?

a. **Competition based on capitalist mechanisms** for regulating production is based on:

- Size – scale of production,
- Production costs (economies of scale), which will be a factor giving an advantage to large milk producers.

b. **Reducing the number of producers** over a longer period of time – hopefully as little as possible.

Problem 7 ☞

Optimization of the chemical composition of milk and further improvement of its hygienic quality

The **chemical composition of cow's milk is not constant**.

The **variability** in the content of the main components of milk from cows raised in the east of Poland, **measured by the coefficient of variation**, was as follows:

- **fat 19.5%,**
- **protein 13.8%,**
- **lactose 5.3%,**
- **urea 48.6%.**

The modification of the chemical composition of cow's milk is the result of a series of factors that consistently differentiate the levels of its individual components at the production level. In the domestic conditions, these factors include:

- **season of the year,**
- **age of the cow,**
- **stage of lactation and pregnancy,**
- **condition during the milk production period,**
- **diseases (mainly metabolic and udder-related),**
- **feeding technologies used.**

Changes in milk composition result from the genetic traits of the animals (their genotypes), which play a fundamental role in the hormonal regulation of milk component synthesis, **as well as from the levels of nutrients provided in the feed rations** that determine the quantity and quality of the available nutrients for the animals.

Problem 7 ☞

Optimization of the chemical composition of milk and further improvement of its hygienic quality

From a health perspective, the following possibilities for modifying cow's milk should be considered in the future*:

- Ensuring a low ratio of omega-6 to omega-3 fatty acids, ideally around 2:1,
- Increasing the proportion of oleic acid to 25-30% of milk fat at the expense of palmitic acid,
- Increasing the proportion of milk containing the A2 beta-casein variant,
- Increasing the concentration of conjugated linoleic acid 9c, 11t-CLA,
- Increasing the concentration of selenium in milk,
- Maintaining a stable level of iodine.

* - Guliński P., Salamończyk E., Młynek K., 2018: Możliwości modyfikacji składu chemicznego mleka krów. Wydawnictwo Uniwersytetu Przyrodniczo-Humanistycznego w Siedlcach.

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Problem 7

Optimization of the chemical composition of milk and further improvement of its hygienic quality

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A2 Milk

The **beta-casein fraction has two genetic variants**, referred to by specialists as **alleles A1 and A2**.

The **molecules of beta-casein A1 and A2 are essentially identical**, differing by only one of the 209 amino acids.

In the A2 variant, proline is present at position 67 of the protein chain, while the **A1 "mutant" has histidine** at this location.

According to Ul Haq et al. (2014) and Jianqin et al. (2016), the **spatial structure of A1 casein does not allow for its complete digestion into individual amino acids**. These **authors state that the digestion processes of the A1 casein variant lead to the formation of the peptide beta-casomorphin-7 (BCM7) in human stomachs**.

This peptide is the main culprit behind the negative opinions and discussions about milk and its products. **BCM7 is an opioid similar to morphine or heroin.** Therefore, some researchers argue that the consumption of A1 casein is associated with a higher risk of developing common lifestyle diseases (Ul Haq et al., 2014; Jianqin et al., 2016).

Ul Haq M.R., Kapila R., Sharma R., Saliganti V., Kapila S., 2014: Comparative evaluation of cow beta-casein variants (A1/A2) consumption on Th2-mediated inflammatory response in mouse gut. European Journal of Nutrition, 53(4), 1039-1049.
Jianqin S., Leiming X., Lu X., Yelland G. W., Ni J., J. Clarke A. J., 2016: Effects of milk containing only A2 beta casein versus milk containing both A1 and A2 beta casein proteins on gastrointestinal physiology, symptoms of discomfort, and cognitive behavior of people with self-reported intolerance to traditional cows' milk. Nutrition Journal, 2.

Optimization of the chemical composition of milk and further improvement of its hygienic quality

A2 Milk

The A2 variant of casein is commonly found in nature and is the only form of beta-casein in almost all mammals.

The gene coding for beta-casein, CSN2, is most commonly inherited by cows from both parents belonging to cultured dairy breeds used in economically developed countries (Kamiński et al., 2007).

Animals of these breeds most often have the A1/A1 genotype, producing only A1 casein, or A1/A2, resulting in milk that contains equal amounts of A1 and A2 casein.

Few cows have exclusively A2/A2 genes (meaning their milk contains only A2 casein). **Breeds of cattle with this desirable genotype are most commonly found in developing countries, primarily in Asia and Africa.**

* - Kamiński S., Cieślińska A., Kostyra E., 2007: Polymorphism of bovine beta-casein and its potential effect on human health. Journal of Applied Genetics, 48, 189-198.

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Problem 7 ☞

Optimization of the chemical composition of milk and further improvement of its hygienic quality

A2 Milk

In Australia and New Zealand, "A2 milk" is available in every supermarket, and one of the companies producing it (A2 Milk Company) has already captured 12% of the Australian market.

Kamiński S., Cieślińska A., Kostyra E., 2007: Polymorphism of bovine beta-casein and its potential effect on human health. Journal of Applied Genetics, 48, 189-198.

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Summary

The principal problems in the management and breeding of high-yielding dairy herds include:

- Increasing milk yield coupled with a decline in the productive lifespan of cows.
- Prolonging the duration of milk production (lactation).
- Deterioration of reproductive performance indicators.
- Inflammatory conditions of cow udders and their negative impact on milk yield and quality.
- Challenges in balancing feed rations, leading to excessive urea levels in milk.
- Consequences of negative energy balance in dairy cows, including ketosis and the presence of ketone bodies in milk.
- Transitioning from a quota system to a competitive market system, resulting in increased unit milk yield as a fundamental condition for success in the milk market.
- Optimization of the chemical composition of milk and further improvement of its hygienic quality.

References Used in the Preparation of the Lecture

Dane Polskiej Federacji Hodowców Bydła i Producentów Mleka.

Guliński P., 2017: Bydło domowe hodowla i użytkowanie. Wydawnictwo Naukowe PWN Warszawa.

Guliński P., 2021: Ketone bodies – causes and effects of their increased presence in cows' body fluids: A review, Veterinary World, 14(6), 1492-1503.

Guliński P., Salamończyk E., 2023: Evaluation of lactational excretion of urea and ammonia in dairy cattle herds. Animals Science and Genetics, 19(1), 69-82.

Guliński P., Salamończyk E., Młynek K., 2016: Improving nitrogen use efficiency of dairy cows in relation to urea in milk - A review. Animals Papers and Reports, 34(1), 5-24.

Guliński P., Salamończyk E., Młynek K., 2018: Możliwości modyfikacji składu chemicznego mleka krów. Wydawnictwo Uniwersytetu Przyrodniczo-Humanistycznego w Siedlcach.

Hanson M., 2023: Is it Time to Rethink Dairy Cow Lifespan? Dairy Herd Management, 8.

Jianqin S., Leiming X., Lu X., Yelland G. W., Ni J., J. Clarke A. J., 2016: Effects of milk containing only A2 beta casein versus milk containing both A1 and A2 beta casein proteins on gastrointestinal physiology, symptoms of discomfort, and cognitive behavior of people with self-reported intolerance to traditional cows' milk. Nutrition Journal, 2,

Jonker, J.S., Kohn, R.A., Erdman, R.A., 1999: Milk urea nitrogen target concentrations for lactating dairy cows fed according to National Research Council recommendations. Journal of Dairy Science, 82 (6), 261-1273.

Kamiński S., Cieślińska A., Kostyra E., 2007: Polymorphism of bovine beta-casein and its potential effect on human health. Journal of Applied Genetics, 48, 189-198.

Kebreab, E., France, J., Mills, J.A., Allison, R., Dijkstra, J., 2002: A dynamic model of N metabolism in the lactating dairy cow and an assessment of impact of N excretion on the environment.Journal of Animal Science, 80 (1), 248-259.

Sawa, A., Bogucki, M., 2009. Długowieczność krów i przyczyny ich brakowania. Animal Science and Genetics, 5(2), 55-62.

Shilovsky, G.A., Putyatina, T.S. & Markov, A.V., 2022: Evolution of Longevity as a Species-Specific Trait in Mammals. Biochemistry Moscow 87, 1579–1599.

Ul Haq M.R., Kapila R., Sharma R., Saliganti V., Kapila S., 2014: Comparative evaluation of cow beta-casein variants (A1/A2) consumption on Th2-mediated inflammatory response in mouse gut. European Journal of Nutrition, 53(4), 1039-1049.

Vredenberg I, Han R, Mourits M, Hogeveen H and Steeneveld W., 2021: An Empirical Analysis on the Longevity of Dairy Cows in Relation to Economic Herd Performance. Front. Vet. Sci. 8, 646672.

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Thank you for your attention!

This presentation has been supported by the Erasmus+ KA2 Cooperation Partnerships grant no. ***2021-1-SK01-KA220-HED-000032068 "Innovation of the structure and content of study programs in the field of animal genetic and food resources management with the use of digitalisation - Inovácia obsahu a štruktúry študijných programov v oblasti manažmentu živočíšnych genetických a potravinových zdrojov s využitím digitalizácie"****. The European Commission support for the production of this presentation does not constitute an endorsement of the contents which reflects the views only of the authors, and the Commission cannot be held responsible for any use which may be made of the information contained therein.*

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