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RESULTS OF DETERMINING OF SOME PHYSICAL AND MECHANICAL PARAMETERS OF MIXED FEEDS, PREPARED BY TMR TECHNOLOGY

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ABSTRACT

Our country has been supporting the intensified cattle farms by policies and establishing as more farms in order to stabilize the population food supply and reduce the seasonal dependence of strategic food. The highly developed countries have been commonly using the TMR fodder technology for the intensified animal husbandry. This article analyses the main parameters of the usage and technological operation of the TMR fodder machines.

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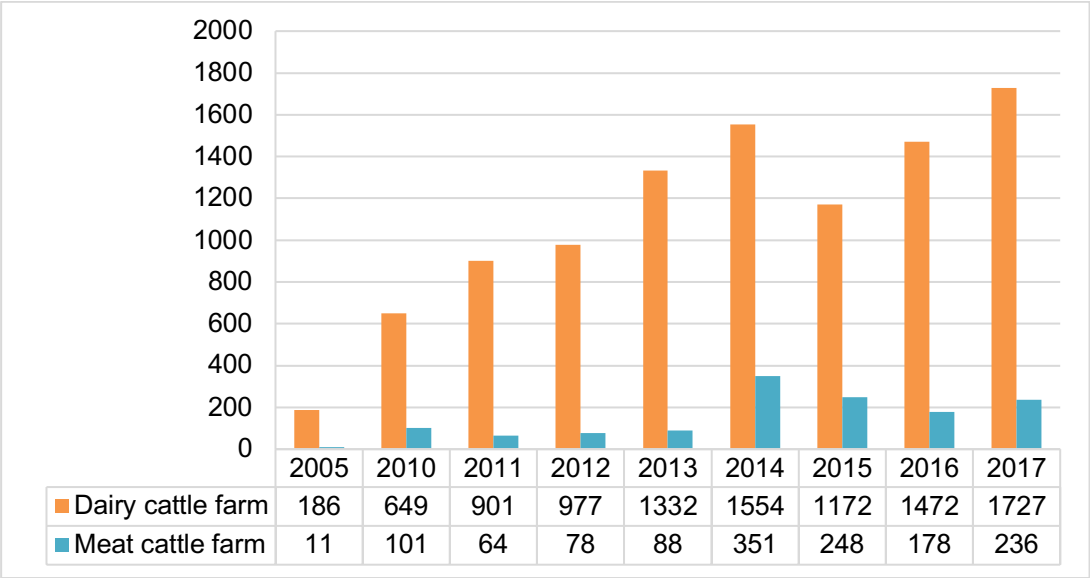
Introduction.

Under the harsh climatic conditions of our country, the demand for using fresh vegetables, milk and dairy products has been increasing. In order to meet this demand, the country has been supporting the establishment of intensified cattle farms.



	2005	2010	2011	2012	2013	2014	2015	2016	2017
Dairy cattle farm	186	649	901	977	1332	1554	1172	1472	1727
Meat cattle farm	11	101	64	78	88	351	248	178	236

Fig. 1. A chart showing the dairy and meat farms

The government has been focusing on developing intensified animal husbandry due to the necessity to provide the urban and settlement population with safe food. In connection to it, number of intensified farms and number of related entrepreneurs have increased recently (fig. 1).

Although it is necessary to increase the number of dairy cattle in order to increase the milk production, method of feeding the cattle is also important.

Today, the livestock has been commonly fed separately by grass and other fodder in Mongolia. Weakness of this method is that the dry grass produces much waste, the cattle food misbalances digestion and metabolism dynamics and rather unsuitable for the intensified livestock breeding.

When feeding under this method, various forage composition cannot ferment in cattle abdomen simultaneously and fermented forage produce different pH values. Therefore, feeding separately by rough forage and pungent fodder increases the pH fluctuation in the abdomen (figure 2). Different forages have different compositions and tastes, therefore, cattle tends to reject easily and dislike the forage.

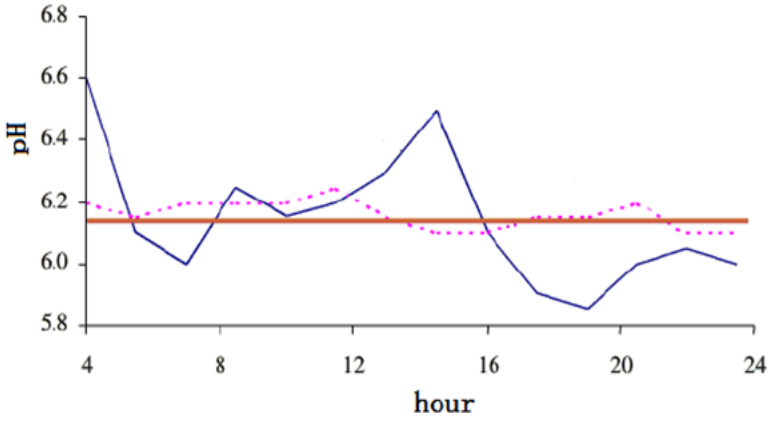


Fig. 2. pH conversion in cattle abdomen after feeding

In order to overcome the weaknesses of the traditional forage methods, the developed countries are commonly using the total mixed ration (TMR) fodder technology in intensified cattle farms [1]. This technology is based on the forage required for the cattle on daily basis at different steps of cattle growth. The forage specialist puts all the forage processed according to the compositions to

the designated TMR machine, mixes until it becomes a forage with standard amount and mixes and then, uses as single feed.

TMR machine is the most suitable in intensified livestock husbandry for feeding and breeding dairy and meat cattle and sheep [2].

Total Mixed Ration.

The total mixed ration (TMR) technology is intended for feeding chewers and it mixes the rough fodder, pungent fodder and supplements with standard amount, cuts in suitable length and produces ready forages [3].

The TMR technology was commonly used in the Great Britain, United States and Israel. Soon, it was used in Canada, japan and Egypt [4].

Today, the TMR technology has been widely used in such countries with highly developed milk production as the United States, Canada, Israel, Netherlands and Italy.

As for the Asian countries, Korea and Japan are commonly using the TMR technology and over 50% of dairy cattle farms have used this new technology and reached satisfied results [4].

In 80s of 20th century the technology entered China and today Beijing, Shanghai and Guangjou of China are widely using this technology. In particular, a cow milk yield continuously increased in Shanghai and reached on average 8000-9000 kg a year, which shows the great efficiency of this technology.

The main equipment for the TMR technology is the fodder mixer and it is classified as vertical and horizontal axis, vehicle, trailer and permanent [4].

Fig. 3. TMR machine classification
a-vehicle TMR machine b-trailer TMR machine c-permanent TMR machine d-horizontal axis TMR machine e-vertical axis TMR machine

Mixed Fodder Ingredients.

TMR fodder mostly consists of rough forage, pungent fodder and supplements. Raw materials for the rough forage include green grass and straws from arable farming; raw materials for pungent fodder include proteins and liquid soup fodder; and supplements include minerals, vitamins and starch.

This piloting model identified the composition of the materials to be mixed in relation to the dairy cattle diet forage structure. It included grass, alfalfa silo, silo and oats to rough forage; cotton seeds, sugar beet mixture, corn cuts and corn flour to the pungent fodder and fat acid calcium and anti-fermenting agents and powder salt to the supplements.

The table below shows the composition of the mixed fodder for the dairy cattle farm [5].

Table 1.Composition of Mixed Fodder

№	Fodder ingredients.	Volume (%)
1	Grass	2.10
2	Red clover silo	16.80
3	Silo	25.20
4	Oats	2.94
5	Cotton seeds	3.80
6	Sugar beet mixture	3.15
7	Corn cuts	6.30
8	Corn flour	25.20
9	Fat acid calcium	1.04
10	Anti-fermenting agent	0.04
11	Powder salt	0.83
12	Water	12.6

Fig. 4. Tools and equipment for the experiment (1-*Grinder, 2-Tractor, 3- Horizontal TMR machine, 4-Sieve (hole size 30mm, 8mm, 5mm diameter 4-layered sieve) and electric weight (accuracy 0.01g), 5-Rotation frequency gauge, 6-Ruler, 0.1m 7-Microwave, 8-Stopwatch, (accuracy 1 sec), 9-Detector of friction angle*

Comparision of the Traditional Method and TMR Fodder Method.

We divided two groups in the cattle farm: TMR fodder group and traditional fodder group, selected 15 cattle with same age, number of breeds and weight, recorded and analyzed the production performance data from the first month of milking until the last month [6]. Fodder composition and forage level are shown in table 2.

Table 2. Fodder Composition and for the High Breed Cattle

Forage components	**TMR forage**	**Traditional forage**
Grass	2.1	15.88
Cotton	---	4.6
Clover silo	16.8	14.23
Silo	25.2	29.34
Oats	2.94	2.94
Cotton seeds	3.8	---
Sugar beet mixture	3.15	---
Corn cuts	6.3	12.65
Corn flour	25.2	25.2
Fat calcium	1.04	1.04
Anti-fermentation struggle	0.04	0.04
Powder salt	0.83	0.83
Forage experiences		
Protein (%)	14.71	14.76
Correct energy of milk yield (Mcal · Kg-1)	1.57	1.57
Ca(%)	0.61	0.63
P(%)	0.48	0.49

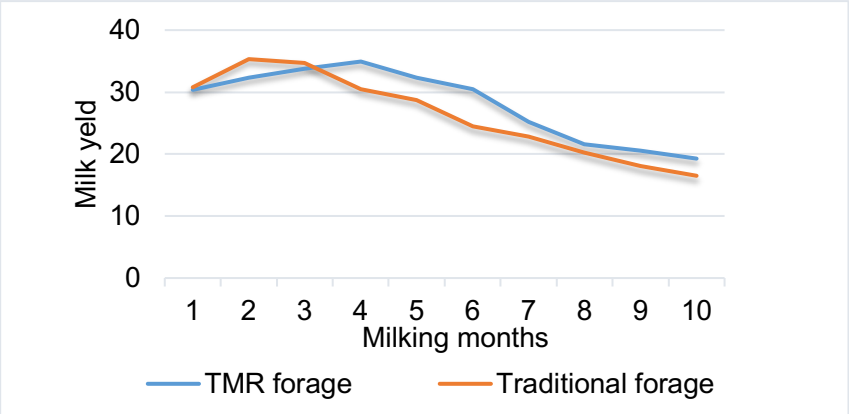


Fig. 5. Graphic of the impacts of the TMR fodder to the milk yields of the cattle (kg)

During the total milking period the average milk yields of the dairy cattle increased on average by 7.09% compared to the traditional fodder group, however, it did not reach significant level ($p>0.05$).

Table 3. Imapct of TMR Fodder to the Milk Fat (KG)

Milk month	**Traditional forage**	**TMR forage**
1	1.24±0.3	1.20±0.19
2	1.39±0.32	1.31±0.67
3	1.32±0.28	1.42±0.21
4	1.12±0.13	1.45±0.21
5	1.10±0.15	1.26±0.15
6	0.85±0.25	1.14±0.12
7	0.78±0.18	0.89±0.12
8	0.78±0.23	0.83±0.19
9	0.69±0.27	0.88±0.25
10	0.64±0.32	0.78±0.23

During the rush hours of milk production the TMR group stored longer and after the rush hours reduced slowly and created a difference from the yields of the traditional fodder group, so it increased the milk production during the overall milking period.

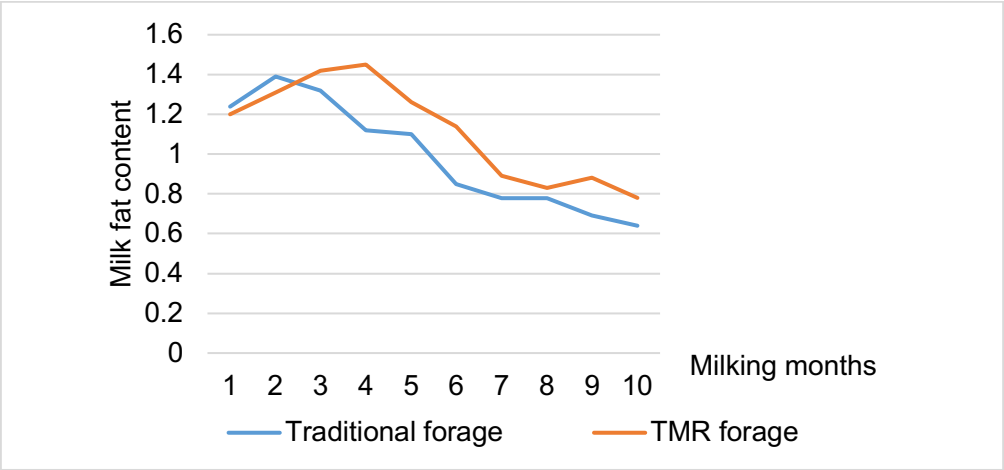


Fig. 6. Graphic of the impacts of the TMR fodder to the milk fat

The attitudes in figure 6 show that the amount if milk fat for the TMR group increased from January to April and reached its maximum in April and reduced slightly from April to October. The traditional group showed increase from January to February and decrease from March to October. According to the statistical analysis to the milk fat, TMR group is higher than the traditional group by 29.46% and 34.12% in April and June respectively and this difference is significant ($p < 0.01$). It is higher than the traditional group by 14.55% in May and shows high difference ($p < 0.05$).

Physical Properties of the Fodder

The experiments on determining the moisture content, friction index and volume weight of the horizontal TMR machine was executed according to the following methodology [7].

Moisture amount was calculated by formula:

$$W = \frac{G_2 - G_1}{G_1 - G_0} \cdot 100\% \quad (1)$$

Where: G_0 – empty buc weight, g; G_2 – buc weight with pre-dry sample, g; G_1 – buc weight with post-dry sample, gr

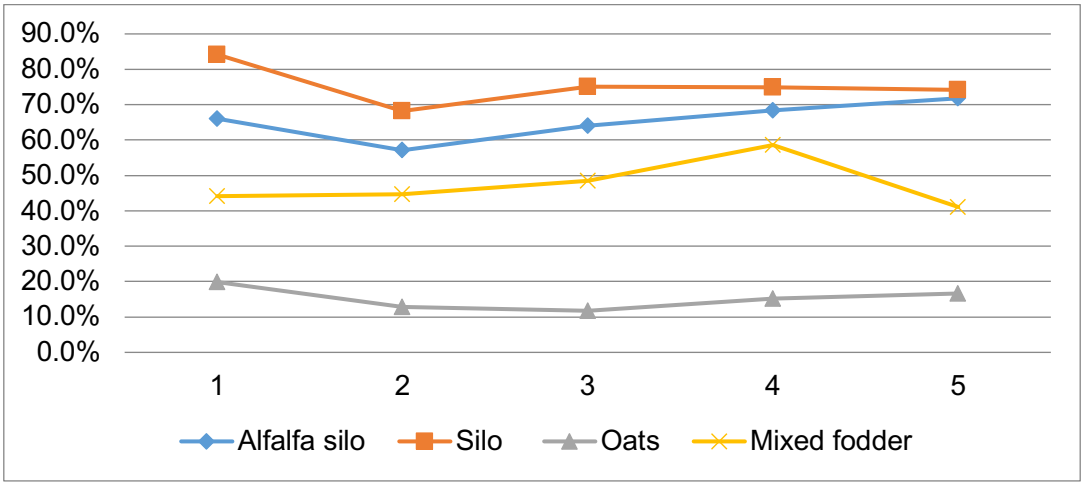


Fig. 7. Results of analysis of determining the moisture amount

Table 4. Results of Material Weight

Test average	Alfalfa silo		Silo		Oats		Mixed fodder	
	Pre-dry weight (g)	Post-dry weight (g)	Pre-dry weight (g)	Post-dry weight (g)	Pre-dry weight (g)	Post-dry weight (g)	Pre-dry weight (g)	Post-dry weight (g)
1	279.5	168.4	420.3	228.2	126.7	105.7	358.6	248.7
2	273.7	174.2	419.5	249.4	124.5	110.3	351.7	243.1
3	275.3	167.9	416.7	238.1	129.3	115.7	349.2	235.2
4	271.9	161.5	422.6	241.7	117.6	102.1	362.4	228.5
5	274.2	159.6	424.1	243.5	121.2	103.9	347.5	246.3
Average (%)	65.4 %		75.3%		15.3%		47.4 %	

According to the scientists, the most suitable moisture of the mixed fodder is 40-50% and higher moisture reduces the amount of dry substances in the fodder and lower moisture weakens the taste and reduces the appetite. If the moisture content in the mixed fodder exceed 50%, amount of dry substances to be eaten by the livestock with 100 kg of alive weight will reduce by 0.02 kg per 1% of increase.

Therefore, the experiment shows that the moisture content of this mixed fodder meets the standard requirements.

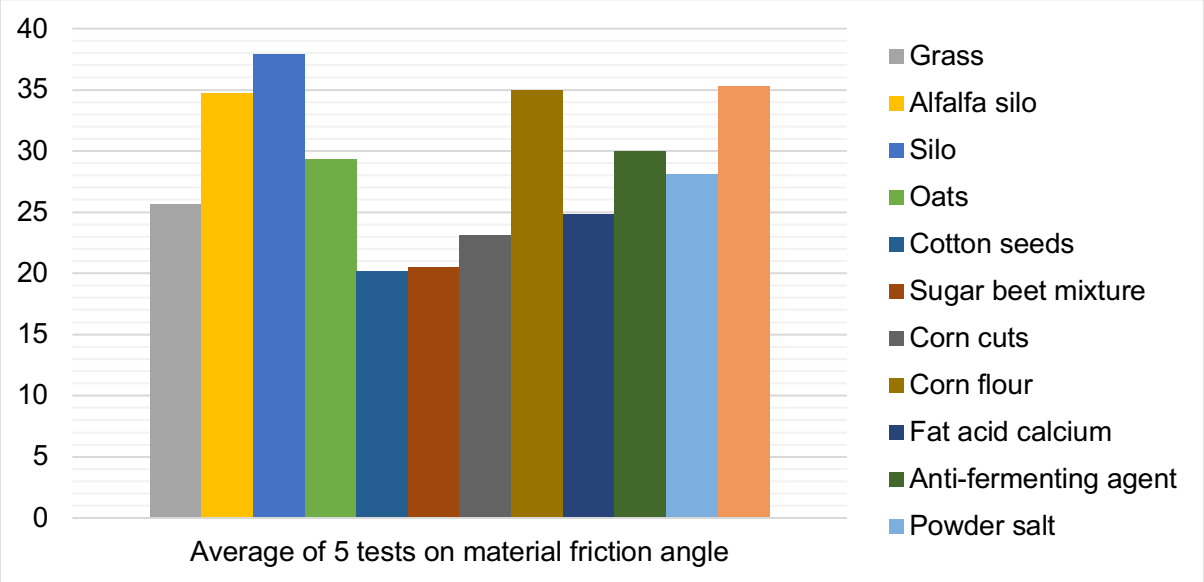


Fig. 7. Graphic of material friction angle

Material friction angle was calculated by formula:

$$\gamma = \frac{\sum M}{5*2} \quad (2)$$

Where: γ– fodder weight, kg/m^3; M –mass of every material, kg

Conclusions.

According to the JB/T 9014.5—1999 standard the mixed fodder weight is 240-400 kg/m3, moisture 40-50% and friction angle is 35°- 40°. Therefore, the test results of mixed fodder weight of 248 kg/m3, moisture 47.4% and friction angle of 35.3° meet the standard requirements.

Physical, chemical and mechanical properties of the mixed fodder meet the zoo-technical requirements to the technological quality of the raw materials of forage. By determining these indicators of technological properties it is possible to use as the rationale for developing programs and projects for fodder plants and selecting related equipment and tools.

Table 5. Result of Friction Angle and Weight of Materials

Material	**Weight (kg/m^3)**	***Average of 5 tests on material friction angle***
Grass	66	25.6
Alfalfa silo	199	34.7
Silo	208	37.93
Oats	102	29.3
Cotton seeds	3328	20.12
Sugar beet mixture	343	20.5
Corn cuts	432	23.1
Corn flour	668	34.95
Fat acid calcium	213	24.79
Anti-fermenting agent	269	29.94
Powder salt	217	28.04
Mixed fodder	248	35.3

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