Dynamics of development of livestock farming in Uzbekistan and the EAEU countries

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Abstract. The calculation of time series data in determining and forecasting the dynamics of livestock growth requires the use of econometric models. Currently, experts have extensive experience and knowledge in the application of univariate correlation and regression analysis in the processing of statistical data. The state is discussing the problems of choosing a model and confirming its adequacy in assessing and forecasting the state of the livestock, and also constructing equations that satisfy its econometric criteria. The results have been confirmed; the models developed by the authors can be used to predict the number of livestock and poultry, both in the preliminary results of the EAEU and in our republic. Keywords. Dynamics of real livestock, time series modeling, forecasting livestock growth in Uzbekistan, correlation, regression parameters, Fisher and Student tests.

1 Introduction

The Eurasian Economic Union (EEU) is an integration project on the territory of the former union. It should be noted that between the member states of the EEU (Russia, Belarus, Kazakhstan, Armenia and Kyrgyzstan) and the common economic space with a unified customs system, freedom of movement of goods and services, movement of migrants and movement of capital is ensured. was formed.

The Eurasian Economic Commission (EEC) is a permanent national governing and regulatory body composed of deputy heads of government of member states and a commission of three members from each country. The decisions of the Commission are binding on all states.

The Eurasian Economic Commission performs 170 functions of the economic union: including customs, tariff and notary regulation; regulation of customs administration; regulation of sanitary, veterinary and phytosanitary measures; regulation of the establishment of trade regimes in relation to third countries; defining macroeconomic and competition policies; industrial and agricultural subsidies, natural monopolies, government procurement, transport and logistics activities, etc.

It is appropriate to mention some points here.

What is the rate of development of agricultural products such as livestock and poultry in EOII countries, subject to mutual assistance or investment? Is growth expected through

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integration? Are there big changes? What are the results of the investment? Profit or loss is expected. To find answers to these questions, this article analyzes the indicators of livestock and poultry in the EEU countries and our republic in the context of different countries.

2 Methodological analysis

Some studies show that foreign investment is not always successful[1]. Hoang et al. (2010) conducted a study in 61 regional provinces of Vietnam between 1995 and 2006 to determine the causal relationship between foreign direct investment (FDI) and economic growth [2]. Used a panel data model for 671 observations and found a positive effect of FDI on economic growth. In addition to them, Kim D. et al. (2003) conducted a similar study in South Korea based on data for 1955-1999 and concluded that the impact of FDI on economic growth exists, but it is not very significant[3]. However, Mensinger J. (2003) in his study conducted in the European Union during the period 1994-2001, found that FDI had a negative impact on 8 countries of the Union when causality established using Granger tests showed that investment beat spent on the purchase of fixed assets[1].

Institutional governance is important for the economic development of a country, for the smooth functioning of all sectors and aspects. Nazima Ellahi et al (2021) examined whether growth in all dimensions ultimately leads to financial growth in a country and, based on twenty years of research, concluded that effective mobilization of physical and human capital is essential for economic development, which depends largely on the quality of management institutions[4]. A well-functioning institutional structure plays an important role in the long-term development of an economy, say Kutan, AM et al. (2017) cited in [5]. Lowe S.H. and Habibullah M.S. (2009) similarly argue that institutional quality is an important factor that helps benefit financial sector development and leads to economic growth through the rule of law and control of corruption. [6].

In econometric modeling, the relationship of information is built on the basis of indicators obtained as a result of empirical observation or confirmed statistical data. This is confirmed by the following cases. In a paper where a meta-analysis of adding garlic to poultry diets was done[7], it was found that garlic extract provided better fattening for chickens, while others fed garlic powder and oil showed normal fattening. All analyzes in Open Meta-analyst for Ecology and Evolution (OpenMEE) software were performed at 95% confidence intervals. Household rice sales for sixty months were determined using the following methods: least squares, mean-declining method, exponential unit and binary method and Winters method, absolute errors, absolute and standard deviation [8]. The future selling price of rice is estimated using the forecasting method. A study modeling cost increases for cotton grown using groundwater extraction and well irrigation in the Texas high plains[9] identified parameters for increasing soil moisture through soil drainage and achieving positive results. were determined based on the CROPGRO-Cotton model.

The situation with Ukrainian livestock farming and food supply for participants in the agro-industrial products market was compared with Germany, France, Italy and Poland. This study relied on empirical methods of understanding: observation, comparison, description, measurement and statistical methods. Due to the increase in the debt burden of external creditors, the inflow of foreign direct investment did not decrease, the growth of capital investment per capita slowed down, and as a result it was concluded that instability of food security in Ukraine.

Most studies based on the methodology of modeling the growth and development of agricultural products and determining the relationship of factors affecting yield depend on empirical or metadata for each case considered.

It is natural to raise the question about the level of growth and the place of independently developing agriculture in Uzbekistan within the perimeter of various difficulties and difficult

conditions of a market economy, the impossibility of entering the world market and quite internal problems. The following discusses a comparison of our republic with the countries of the EEU in terms of livestock production indicators.

3 Solution and research result

3.1. Growth trend in data and indicators of livestock and poultry breeding in the countries of the EEU and our republic

Time series data collected from 2006 to 2023 for GII countries and Uzbekistan were compared. The main source of information is the Eurasian Economic Commission with publications and information on rural products grown in the industry [11] and the website of the State Statistics Committee of Uzbekistan [10-12].

To determine the dynamics of livestock growth in relation to population growth, the indicators of the countries of the EEU and Uzbekistan were compared according to a number of parameters: cattle, cows, sheep and goats together, horses and poultry. To do this, based on data from the EEC and source [12], Table 1 was created, and on their basis, Figures 1-3 were built, respectively.

Table 1. Information on the number of livestock and poultry in Uzbekistan and the countries of the EEU (at the beginning a, thousand heads)

years	Russia	Uzbekistan	Kazakhstan	Belarus	Kyrgyzstan	Armenia
Cattle						
2006	21625	6571,4	5457,4	3980,2	1074,8	592,1
2007	21561,6	7044,6	5660,4	3989	1116,7	620,2
2008	21501.6	7457,9	5840,9	4007	1168	629,1
2009	20952.1	8026,2	5911,6	4131	1224,6	584,8
2010	20540	8510,7	6095.2	4151	1278,1	570,6
2011	19793,9	9094,7	6175.3	4151,3	1298,8	571,4
2012	19900.8	9642,7	5702,4	4246,8	1338,6	599,2
2013	19679,8	10141.3	5690	4367	1367,5	661
2014	19272,6	10607.3	5851,2	4321,2	1404,2	677,6
2015	18919,9	10995.2	6032,7	4363,7	1458,4	688,6
2016	18630,9	11641,3	6183,9	4356,5	1492,5	701,5
2017	18346.1	12181.4	6413.2	4299,3	1527,8	655,8
2018	18294.2	12471	6764,2	4362,2	1575,4	590,6
2019	18152.1	12814.1	7150,9	4340,4	1627,3	571,9
2020	18122.3	12949,7	7436,4	4294,9	1680,8	579,3
2021	18027,17	13 154,3	7850.04	4288,1	1715,77	613,4
2022	17649,6	13 544,4	8192,4	4232,4	1750,4	559,6
2023	17488,57	13 853,5	8538.1	4209,3	1783,5	501,9
Cows						
2006	9522.2	2821,2	2442,6	1565 г.	565,1	297,1
2007	9359,7	2982,5	2600,4	1506	584,9	307,1
2008	9286,4	3124,9	2605,6	1459	607,2	310,6

2009	9060,3	3327,1	2675,4	1452	635,6	283
2010	8924,9	3535,7	2717,3	1444,6	664,3	273,9
2011	8713	3758,1	2751,3	1478,1	666,5	272,6
2012	8807,5	3878,4	2521,8	1477,4	684,2	283,3
2013	8657,2	3935	2692,3	1519,3	699,3	303,3
2014	8430,9	4020,6	2734,9	1524,5	718,5	310
2015	8263,2	4084,3	2835.2	1534 г.	744,3	314
2016	8115.2	4173,5	2999,3	1511,8	757,4	318,6
2017	7966	4217,3	3209,9	1503.2	769,9	296
2018	7950,6	4336,5	3362,4	1500,2	789,8	266,8
2019	7942,6	4626	3576,5	1497,7	812,6	254
2020	7962,5	4663,5	3769,8	1495,1	835,3	251,7
2021	7898,3	4 729,4	4008.27	1482,6	855,1	265,81
2022	7783, 6	4 863,2	4235,7	1456,7	868,8	246,1
2023	7734, 7	4 956,5	4462	1447,3	885,7	222,1
Sheep and goats						
2006	18581,4	11351,9	14334,5	121	3876	591,6
2007	20194.5	12016.2	15350.3	122	4046,9	632,9
2008	21577.1	12635,6	16080	124	4251,8	637,1
2009	21742,8	13523.3	16770.4	126	4502,7	559,2
2010	21937.1	14432,6	17369.7	127	4815,5	511
2011	21733,7	15340.9	17988.1	124	5037,7	532,5
2012	22726,9	16189	18091,9	125	5288,1	590,2
2013	23998,9	17128,3	17533,3	133	5423,9	674,7
2014	24151.4	17717,6	17560,6	131	5641,2	717,6
2015	24445.4	18438.9	17914,6	140,5	5829	745,8
2016	24606,5	19118.8	18015.5	152,6	5929,5	778,1
2017	24716,9	19697,9	18184.2	157,8	6022,5	727,1
2018	24389.1	20640.9	18329	154,6	6077,8	660,1
2019	23129.3	21580.5	18699.1	150,9	6167,9	638,3
2020	22617,6	21906,9	19156	148,7	6266,7	662,5
2021	21659,9	22 458,8	20059.5	144,4	6278,7	717,8
2022	20959.3	22 970,3	20876,8	136,	6278.1	713,7
2023	20831.2	23 602,5	21786	130,8	6201	701
Horses						
2006	1316,6	158,1	1163,5	167,6	345,1	12.3
2007	1300,6	162,4	1235,6	156	347,5	12,6
2008	1307	168,3	1291,1	147	355,6	11,8
2009	1324,7	175,8	1370,5	137	362,4	11.3
2010	1330,2	180,6	1438,7	125,6	373	10,8
2011	1284,2	187,4	1528,3	113	378,4	10.1
2012	1287,6	195,2	1607,4	100,3	389	9,9

2013	1287,3	202,2	1686,2	92,1	398,8	10,8
2014	1266,2	208,8	1784,5	82,2	407,4	11,7
2015	1249,3	213,4	1937,9	73,2	433	11.4
2016	1240,6	216,9	2070.3	63,6	449,6	11.4
2017	1216,4	221,4	2259,2	55,3	467,2	10,6
2018	1238,6	230,6	2415,7	49	481,3	10
2019	1283	242,5	2646,5	43,3	498,7	10,7
2020	1310,9	247,1	2852,3	38,1	522,6	11,4
2021	1302,9	253 625	3139,8	29.1	539	13.1
2022	1298,6	260 393	3489,8	25,6	547,3	13,9
2023	1310,5	269 002	3856	22,7	554	13.2
In poultry farming						
2006	357467,9	20540.3	26215.5	28476,7	4279	4054,1
2007	374686,6	24188.4	28239.3	28700	4472,6	4098,1
2008	388433.7	26118.9	29506,8	29400	4539,2	4018.2
2009	404337.6	29505.4	30148.4	31200	4364,8	4188,2
2010	436197.1	33053	32686,5	34086,7	4535,8	4134,6
2011	449710.7	37733.3	32780,6	37537.1	4749,9	3462,5
2012	473252,9	42818.4	32870.1	39852,6	4815,3	4023,5
2013	495513.7	47485,8	33474	42379,7	5076,6	4056
2014	493945.1	52363.2	34173.1	45733,6	5385,7	4101
2015	524252.2	56276.3	35020	48200	5420	4122
2016	543913,5	61349.2	35612,9	48517,7	5586,2	3900
2017	550169.4	67037.7	36910	49516.1	5673,6	3800
2018	552827.2	74870.1	39900	50700	5910,4	4400
2019	541494.2	86374.8	44337,9	51200	6009.7	4152,1
2020	544943,9	87859,7	45041.4	53000	6211.2	4568,1
2021	519779	89 589,7	43335	47532	6070	4204
2022	539097	91 935,0	47885	48109	5925	4827
2023	551226	97 351,5	49788	52771	6369	4186

If you pay attention (Fig. 1), the largest number of cattle is in Russia - more than 17.4 million, and the second figure belongs to Uzbekistan (about 13.9 million).

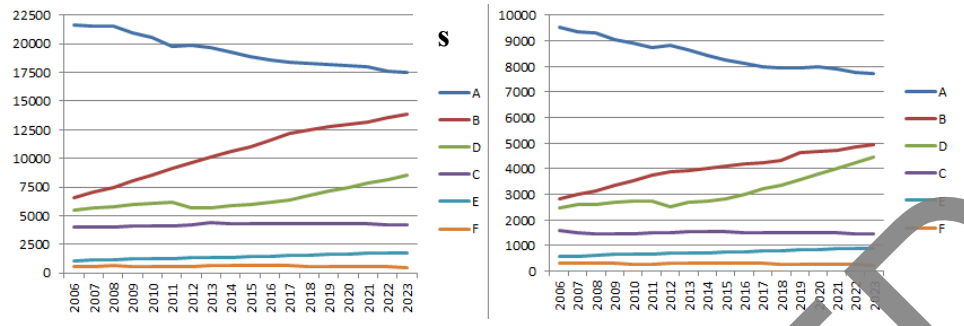

Fig. 1. In Uzbekistan and EOII countries, cattle(s) and cows (r)

Abbreviations in the picture: A - Russia, B - Uzbekistan, C - Kazakhstan, D - Belarus, E - Kyrgyzstan, F - Armenia.

However, over the last three years, the number of cattle in Russia has decreased by 663 thousand heads, while in Uzbekistan the increase is actually more than 1.0394 million (1s diagram). Cows are also included in this figure.

Among the types of livestock in the countries of the EEU and Uzbekistan, cows were also found as a separate object (1d diagram). In Russia, there was no increase in these indicators; the number of cows decreased by an average of 99.31 thousand over 18 years, and in Uzbekistan, on the contrary, the increase amounted to 118.63 thousand. And in terms of quantity it ranks second.

The growth rates of sheep and goats in the countries under consideration are presented in the 2s diagram. If you look at this diagram, the average growth in Uzbekistan is 680.59 thousand, in Kazakhstan - 413.97 thousand. Over these years, there has been no increase in these indicators in Russia; on the contrary, the number of sheep and goats decreased by 459,620 heads.

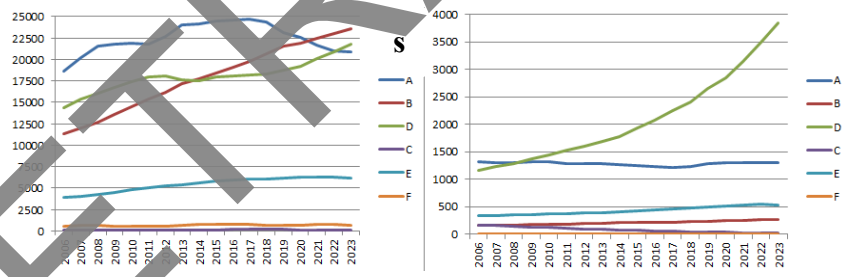

Fig. 2. Sheep and goats in Uzbekistan and EOII countries and horses (r).

According to the 2r-diagram, Kazakhstan has the largest number of horses (3.856 million), their growth is 149.6 thousand per year, and Russia, in second position, has a total of 1.310 million horses, but no growth is observed in this indicator . In Kyrgyzstan and Uzbekistan, the number of livestock increases annually by an average of 10.5 and 6.16 thousand horses per capita.

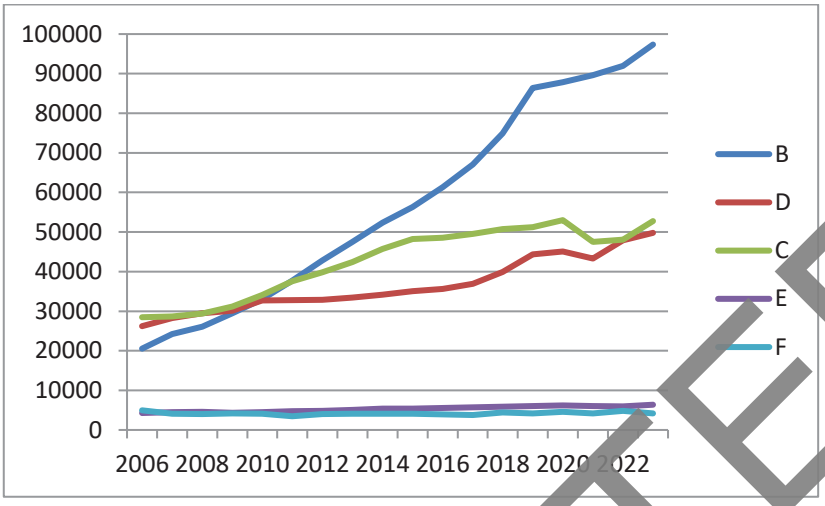

Fig. 3. Poultry growth rate in Uzbekistan and the countries of the EEU

The growth rates of poultry in the countries of the EEU and Uzbekistan are presented in Figure 3. Judging by Table 1, the poultry population in Russia is about 551 million heads. For example, Uzbekistan is in second place, this figure is more than 97 million, but this is 5.66 times less than Russia. However, the relative growth in Uzbekistan in recent years is 105 percent (109 percent in Belarus and 102 percent in Russia).

3.2. Data Modeling

Table 2 was created on the basis of calculations using the least squares method for processing the given data (Table 1) and theoretical models were built to characterize the statistical data. The correlation and regression parameters reflecting the econometric model were identified and presented in this table.

Table 2. Growth parameters of livestock species by country of the EEU, computational models and their parameters

Cattle and poultry	The equation	Determination coefficient r^2	Correlation coefficient r	Approximation coefficient	Fisher criterion, F_H		Student's criterion, t_H	
					value	importance	value	importance
Russia								
Cattle	U = -256,54x + 21795	0,96	0,980	1.21	394,16	+	19.85	+
Sheep and goats	U = -62,598x ^{2} + 1294,4x + 17480	0,90	0,949	1,95	145,85	+	12.08	+
Horses	U=0,047x2 $^+$ 5,5966x + 152,09	0,47	0,689	1.41	14.47	+	3804	+
In poultry farming	U= 378629e ^{0,0252x} U= -979,01x ^{2} + 30226x + 313348	0,91 0,97	0,956 0,984	3.51 2.01	169,76 591,09	+ +	13.03 14.26	+ +
Uzbekistan								

Cattle	U=443,19x + 6384,3 Y= -10,354x ^{2} + 639,91x + 5728,5	0,985 0,997	0,993 0,998	2.36 1.13	1083,2 5175,3	+ +	32,91 71,94	+ +
Sheep and goats	U= 741,13x + 10779 U= -9,7406x ^{2} + 926,21x + 10162	0,995 0,9985	0,997 0,9993	1,38 0,70	3082 10661	+ +	55,51 103,25	+ +
Horses	U= 6,4891x + 149,12 U=0,047x2 $^{+}$ 5,6x+152,1	0,996 0,997	0,998 0,999	0,75 0,65	3969, 7 5499,5	+ +	63 74.15	+ +
In poultry farming	U= 4845,7x + 10991 U=59,638x ^{2} + 3712,6x + 14768	0,986 0,989	0,993 0,995	5,62 3,66	1120,3 1452,6	+ +	53,47 38.11	+ +
Kazakhstan								
Cattle	и=156,04x + 5019,1 и = 5176,1e ^{0,023x} и=15,212x ^{2} - 132,98x + 5982,5	0,79 0,72 0,95	0,887 0,848 0,972	6.04 5.42 2.8	58,86 40,96 278,46	+ + +	7,67 6.4 16.69	+ + +
Sheep and goats	U= 313,58x + 15032 U=2,5019x ^{2} + 266,05x + 15191 y = 15178e0,0175x	0, 863 0,8 64 0,871	0, 92 0,9 3 0,933	3.12 3.09 3.08	100,70 101,71 102,7	+ + +	10.04 10.09 10.38	+ + +
Horses	U= 146,09x + 710,62 U=8,8298x ^{2} - 21,672x + 1269,8 y = 1021,8e ^{0,0388x}	0,9 2 0,99 5 0,87	0,9 31 0,9 98 0,934	9.46 2.40 3,66	192 3270 110	+ +	13.87 57,18 10.47	+ +
In poultry farming	U= 1200,3x + 24580 U = 25975e0,0342x U= 45,92x2 + 887,83x + 27488	0,9 4 0,9 1 0,96	0,9 6 8 0,9 56 0,982	4.09 3.3 2,9	237,98 171,96 422,81	+ + +	15.42 13,11 20.56	+ + +
Belarus								
Cattle	и=136,93ln(x) + 3950,4 U= -3,5966x2 + 85,319x + 3838,2	0,69 0,92	0,832 0,961	1,4 0,64	35,98 193,62	+ +	6 13.91	+ +
Sheep and goats	U= 121,09e ^{0,0119x} U =0,1987x2 + 5,3786x + 108,26	0,50 0,63	0,71 0,79	4,73 4,65	15.91 26,71	+ +	3,99 5.17	+ +
Horses	U= -8,8216x + 168,29 y = 0,2453x2 – 13,482x + 183,82	0,982 0,9986	0,999	2.21	11324	+	106,4	+
In poultry farming	U= 28805e ^{0,0388x} U = -102,57x2 + 3491,6x + 21453	0,98 0,95	0,991 0,973	7,71 4.37	875,08 286,61	+ +	29.59 16.93	+ +
Kyrgyzstan								
Cattle	U = 16,984x + 4065,9 U = -3,5966x2 + 85,319x + 3838,2	0,997 0,997	0,999 0,999	0,64 0,64	6348.3 6349,6	+	79,68 79,68	+

Sheep and goats	U=148,17x + 4033,2 U= 1006,2ln(x) + 3406,2 U=-8,61x2 + 316,09x+ 3461 235	0,96 0,996	0,98 0,998	2,68 0,79	312 3237	+ +	318,43 3243,5	+ +
Horses	U= 13,184x + 309,75 U= 322,28e ^{0,0302x} U=y = 0,3207x2 + 7,0916x + 330,05	0,97 0,96 0,98	0,984 0,979 0,99	2.39 1,85 1,51	500,58 376 837,58	+ + +	22.37 19.40 28.94	+ +
In poultry farming	y = 128,09x + 4085,6	0,95	0,975	2.47	314	+	17,72	+
Armenia								
Cattle	y = -1,3063x2 + 22,606x + 547,67	0,44	0,664	5,6	12,62	+	3,55	+
Sheep and goats	U= 572,28e ^{0,0135x}	0,39	0,626	7,77	10,3	+	3.2	+
Horses	U= 0,0354x2 - 0,6137x + 13,188	0,65	0,805	5.07	29,41	+	5.42	+
In poultry farming	U= 8,0922x2 - 143,82x + 4595,7	0,36	0,6	5.25	8,81	+	2,97	+

Although the diagram shows that changes in the indicators of the countries of the EEU have a more linear relationship, the use of a quadratic equation (polynomial) gave an insignificant error in the quadratic deviation of trends.

3.3. Forecasting data calculated based on developed

The growth dynamics of livestock and poultry farming in the republic are presented in Table 1 above. Based on this information, based on econometric studies, models were created (Table 2) and a forecast of future changes in agriculture for these types of livestock and poultry was calculated, presented in Table 3.

Table 3. Breeding livestock and poultry in the republic. forecast

№	years	Cattle	Cows	Sheep and goats	Horses	In poultry farming
1	2006 г.	6827,44	2980,78	11519,87	11519,87	15836,79
2	2007	7270,63	3100,91	12261.01	12261.01	20682.46
3	2008	7713,82	3221.04	13002,14	13002,14	25528.14
4	2009	8157.01	3341,16	13743,28	13743,28	30373.82
5	2010	8600,20	3461,29	14484,41	14484,41	35219.49
6	2011	9043.39	3581,42	15225,55	15225,55	40065.17
7	2012	9486,57	3701,55	15966,68	15966,68	44910.85
8	2013	9929,76	3821,68	16707,82	16707,82	49756,52
9	2014	10372,95	3941,81	17448,95	17448,95	54602.20

10	2015	10816.14	4061,94	18190.09	18190.09	59447,88
11	2016	11259,33	4182.07	18931.22	18931.22	64293,55
12	2017	11702.52	4302.19	19672,36	19672,36	69139.23
13	2018	12145,70	4422,32	20413.49	20413.49	73984.91
14	2019	12588,89	4542,45	21154.63	21154.63	78830,58
15	2020	13032.08	4662,58	21895,76	21895,76	83676,26
16	2021	13475,27	4782,71	22636,90	22636,90	88521.94
17	2022	13918,46	4902,84	23378.03	23378.03	93367.61
18	2023	14361,64	5022,97	24119.17	24119.17	98213.29
19	2024	14804,83	5143.09	24860.30	24860.30	103058.97
20	2025	15248.02	5263,22	25601.44	25601.44	107904.64
21	2026	15691.21	5383,35	26342.57	26342.57	112750.32
22	2027	16134.40	5503,48	27083.71	27083.71	117596,00
23	2028	16577,59	5623,61	27824,84	27824,84	122441,67

* Data for 2024–2028 are estimated and projected using linear models presented in Table 2.

4 Analysis

This study examined methods for applying linear, hyperbolic, logarithmic, exponential and polynomial (quadratic) equations to time series data using least squares for empirical analysis and performed calculations. MS EXCEL software was used to perform the sequence of operations and analyze the results obtained from the developed model.

The main goal was to build models of time series data [13-15] in which the resulting sign is a function of the magnitude of the time variable or other variables associated with the time periods. It should be noted that the correlation coefficient is determined by the following formula (1) in a linear relationship.

$$r = \frac{\overline{xy} - \overline{x} \cdot \overline{y}}{\sigma_x \cdot \sigma_y}, -1 \le r \le 1 \quad (1)$$

where σ_x and σ_u represent the standard deviations of x and y, respectively.

It is known that the assessment of the statistical significance of the constructed regression model is determined based on the Fisher and Student criteria using formulas (2) and (3), respectively [15].

$$F_H = \frac{r^2}{1-r^2} \cdot \frac{n-m-1}{m} \quad (2)$$

$$t_H = |r| \cdot \sqrt{\frac{n-2}{1-r^2}} \quad (3)$$

where n is the number of observations, m is the number of factors. In our study, the number of observations was 18, and the number of factors was 1.

After calculating the actual values of the Fisher and Student criteria, the critical coefficients of these criteria (F_{krt} and t_{krt}) were compared with standard data in tables [14-15]. One factor (m=1) and n=18. observations or from statistical inferences, F_{krt} =4.67 and t_{krt} =4.45. In this case, $F_H > (F_{krt}=4.67)$ and $t_H > (t_{krt}=4.45)$ conditions were met simultaneously, which means that the models we created can be used and are adequate.

When using models, it is necessary to calculate one more coefficient[15]. To do this, compare the actual (y_i) and theoretical ($\hat{y}_i$) values ($(y_i - \hat{y}_i)$) and calculate the difference, which represents the approximation (that is, the deviation). Considering this difference to be positive or negative, it is calculated modulo and the average approximation error is determined using formula (4)

$$\bar{A} = \frac{1}{n}\sum_{i=1}^{n}\left|\frac{y_i - \hat{y}_i}{y_i}\right| \cdot 100 \qquad (4)$$

If the average approximation error does not exceed 8-10%, the correctness of the model choice is taken into account [12,13]. Among the linear, exponential or second order polynomial models identified for a livestock and poultry species, whichever one had the smallest standard deviation error was considered reasonable to accept as the predictive model.

5 Interpretation of results

The results of looking at the data based on the time factor mean that using it to forecast future years' performance will produce results with less variance. For example, coefficient A in a polynomial model determined by the type of Russian cattle: horses, in table. 9 was only 1.41%. This is a very good indicator, but in the logarithmic model it is also 1.80%. However, if we look at the correlation, one has a close to strong correlation (0.69 in the polynomial equation) while the other has a weak correlation (0.93).

In the case of Kazakhstani indicators, more problems were found when modeling the development of sheep, goats and when choosing an exponential model, the correlation coefficient gave a maximum of 0.933. In Belarus, the correlation for cows did not exceed 0.428, and for sheep – 0.79 (4d diagram).

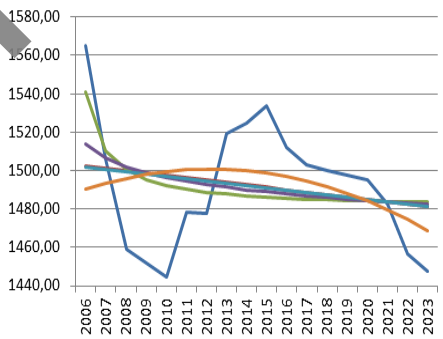

Fig. 4. Approximation results for cows and sheep in Belarus.

According to Armenian data, the correlation did not exceed r=0.664 for cattle and r=0.626 for sheep and goats. Especially when considering poultry data, the correlation did not reach 0.6 even in the best-fitting polynomial regression equation (5s,5r - diagrams). It is known that the value of coefficient A exceeds 9 percent means that the selected model is close to the critical limit, although these indicators are 5.6, 7.8 and 5.3, respectively, the application of

the found regression equations gives only a moderate result. A higher result r=0.8, À =5.1 was obtained when calculating by horse type.

In other republics there are no results below r=0.9 for all types of livestock. This fact means that the models found in the study can be freely used.

It is also possible to express the change in the livestock and poultry population of our republic from year to year using simple linear equations, and the basis of this is that the correlation and determination coefficients are very reliable and exceed 0.98, and if the model is taken in the form of a quadratic equation, the average error approximation (À) does not reach 2%, as can be seen from Table 2. However, for 4 out of 5 types of cattle, polynomial equations were adopted, the deviation error (ε2), and not linear. For comparison, ε the corresponding values in linear and polynomial equations are: 67/30; 23/17; 65/35; 27.43/27.38; 708/623. These data are given in the following sequence: cattle, cows, sheep, goats, horses, poultry. In fact, when viewed as a percentage, these deviations have the following values (linear/polynomial): 0.62/0.29; 0.57/0.43; 0.37/0.2; 13/12.99; 1.24/1.09. Among the selected models, the polynomial equation with the largest mean deviation of 13% for horses was selected (the mean deviation of 13% also applies to the linear equation and was omitted) and ε equal to 623.

If you pay attention to the forecast data given in lines 19-23 of Table 3, then the number of cattle will increase to 355 thousand, cows - to 96 thousand, sheep and goats - to 593 thousand, the number of horses will increase by only 5.19 thousand, and the poultry population will increase to 3877 thousand per year.

6 Conclusions

The livestock and poultry populations in the countries of Russia, Belarus, Kazakhstan, Kyrgyzstan, Armenia, which are members of the EEU, as well as our republic, have been studied for 18 years and identification models (regression equations) for these statistical data have been developed and presented in Table 2.

Correlation and regression analyzes were carried out in the created models, and their adequacy was assessed based on the Fisher and Student criteria. Most of these estimates were calculated to an accuracy of 0.95 percent for models designed to account for statistical deviations that did not exceed the recommended level. Naturally, models that did not meet this requirement were not used in the calculations.

Based on the information obtained in the generated forecasting models, it is shown that the indicators of the republic in the future will be high, and the position of Uzbekistan, which is developing independently in most types of livestock farming (cattle, sheep, goats, in poultry farming), will be more advanced.

The relationship between the development of agricultural products is growing in parallel with population growth: although there are 3 times more of some types of poultry per capita, there are 11 million fewer sheep and goats. There is one cattle for every three people. According to this indicator, for example, in Uruguay, each person has on average more than 3 head of cattle[15]. However, an analysis of the results obtained shows that in this area in Kazakhstan there is a higher increase in the number of livestock and poultry than in other countries of the EEU. But our republic is ahead of the bar in terms of relative growth.

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