Systems analysis when evaluating and forecasting of agricultural enterprises

Análisis de sistemas al evaluar y pronosticar empresas agrícolas

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ABSTRACT

In economic calculations, when conducting some analytical work, any economic indicator, as a rule, is represented as a factor model (or system). In this case, the economic indicator is considered productive, depending on the values of exposures and their changes. This article presents some methodological aspects of assessing the extent to which changes in the value of exposures affect the deviation of the effective indicator. One of the priorities in training of highly qualified specialists of the agro-industrial complex is to teach them how to use the most rational and objective methods of factor analysis, the results of which are necessary to develop and substantiate real and accurate management decisions, the implementation of which in the production and financial activities of agricultural enterprises will contribute to the economic efficiency of the use of material, financial and labor resources with the purpose of increasing the gross production of crop and livestock products, reducing the production cost of its unit, and therefore, improving the overall efficiency of agricultural production. In this regard, the following calculations will allow future specialists to get acquainted with the methodological aspects of factor analysis with different accuracy of intermediate results for the purpose of the most objective assessment of the degree of influence of changes in the values of exposures on the result.

Keywords: effective indicator, exposures, fodder units, agricultural land, productivity, factor analysis.

RESUMEN

En los cálculos económicos, cuando se realiza un trabajo analítico, cualquier indicador económico, por regla general, se representa como un modelo (o sistema) de factores. En este caso, el indicador económico se considera productivo, dependiendo de los valores de las exposiciones y sus cambios. Este artículo presenta algunos aspectos metodológicos de la evaluación de la medida en que los cambios en el valor de las exposiciones afectan la desviación del indicador efectivo. Una de las prioridades en la capacitación de especialistas altamente calificados del complejo agroindustrial es enseñarles cómo usar los métodos más racionales y objetivos de análisis factorial, cuyos resultados son necesarios para desarrollar y corroborar decisiones de gestión reales y precisas, cuya implementación en las actividades productivas y financieras de las empresas agrícolas contribuirá a la eficiencia económica del uso de recursos materiales, financieros y laborales con el fin de aumentar la producción bruta de productos agrícolas y ganaderos, reduciendo el costo de producción de su unidad, y por lo tanto, mejorando la eficiencia general de la producción agrícola. En este sentido, los siguientes cálculos permitirán que los futuros especialistas se familiaricen con los aspectos metodológicos del análisis factorial con una precisión diferente de los resultados intermedios con el propósito de la evaluación más objetiva del grado de influencia de los cambios en los valores de las exposiciones en el resultado.

Palabras clave: indicador efectivo, exposiciones, unidades forrajeras, tierras agrícolas, productividad, análisis factorial.

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RESUMO

Nos cálculos econômicos, ao realizar algum trabalho analítico, qualquer indicador econômico, como regra, é representado como um modelo de fator (ou sistema). Nesse caso, o indicador econômico é considerado produtivo, dependendo dos valores das exposições e de suas alterações. Este artigo apresenta alguns aspectos metodológicos da avaliação da extensão em que as alterações no valor das exposições afetam o desvio do indicador efetivo. Uma das prioridades no treinamento de especialistas altamente qualificados do complexo agroindustrial é ensiná-los a usar os métodos mais racionais e objetivos de análise fatorial, cujos resultados são necessários para desenvolver e fundamentar decisões de gestão reais e precisas, cuja implementação nas atividades produtivas e financeiras das empresas agrícolas contribuirá para a eficiência econômica do uso de recursos materiais, financeiros e trabalhistas, com o objetivo de aumentar a produção bruta de produtos agropecuários, reduzindo o custo de produção de sua unidade, e, portanto, melhorando a eficiência geral da produção agrícola. Nesse sentido, os cálculos a seguir permitirão que os futuros especialistas se familiarizem com os aspectos metodológicos da análise fatorial com diferentes acurácia dos resultados intermediários, com o objetivo de avaliar de maneira mais objetiva o grau de influência das mudanças nos valores das exposições ao resultado. .

Palavras-chave: indicador efetivo, exposições, unidades forrageiras, terras agrícolas, produtividade, análise fatorial.

Introduction

In the course of analytical work on the study of economic phenomena, there is practically always the question of assessing the influence of various causes on a change in indicators reflecting the essence of these phenomena in absolute terms.

For this purpose, the method of factor analysis is used.

At the same time, the effective economic indicator is expressed in the form of a mathematical model, reflecting the dependence of its level on various exposures.

The most frequently used factor models are the ones of multiplicative type, where the effective indicator is presented as a product of several exposures [Fedoskin, 2017].

As an example of such multiplicative factor models, the following ones can be provided:

1. $GY = \sum(S^{total} : 100 * RS^{j}) * P^{j}$, where

GY is the gross yield obtained from all types of agricultural land (in centners to fodder units);

S^{total} is the total agricultural land area (sum of arable land, hayfield and pasture area), ha;

RS^{j} is the relative share of the j–th type of agricultural land in the total area, %;

P^{j} is productivity (output of products from 1 hectare) of the j–th type of agricultural land, centers of fodder units (c.f.u.).

In this model, the total crop gross yield is a productive indicator.

The sum sign indicates that gross yield is derived from several types of agricultural land.

The components of the factor model: the total area of agricultural land (S^{total}), the relative share of each type of land in the total area (RS^{j}) and the productivity of each type of land (output of 1 hectare in centners of feed units - P^{j}) are considered exposures, which objectivity and accuracy effect the value of the effective indicator.

2. ALP = DN * WD * HLP, where

ALP is the annual labor productivity (gross output produced per average annual worker) as an effective indicator, rubles;

DN is the number of days worked per year by one employee, days;

WD is the average working day duration, h;

HLP is the gross yield per one man-hour (hourly labor productivity), rubles.

The presented model has the following exposures: the number of days worked per year by one worker, the average working day (in hours) and hourly labor productivity (gross agricultural output per one man-hour) (in rubles).

It is quite natural that the value of the effective indicator will completely depend on the accuracy of the calculated exposures. In this case, the values of exposures will be the results of intermediate calculations.

Moreover, in order to assess the degree of influence of a change in the value of exposures on the effective indicator, as a rule, the method of factor analysis with one of two methods is used. It can be either the method of chain substitutions or the method of calculating absolute differences (the common name of the two methods is elimination) [Fedoskin, and Fedoskina, 2009].

This technique allows you to exclude the impact of all exposures, besides the one being investigated on the result (the incidence of which is evaluated).

Since the above factor models have a structural indicator, then to assess the incidence of changes in the values of exposures on the effective indicator, one can use the method of chain substitutions.

And this method, in turn, provides for the transition from the original factor model to the final one by successive replacement of the planned (initial) values of the exposures with the actual (final) values.

Therefore, calculations of conditional values are necessary, the values of which will depend on the accuracy of the values of exposures.

It should be noted that the accuracy of the values of exposures will depend on their significance, that is, the number of decimal marks after the point.

Naturally, all this will have a direct impact on the objectivity and reliability of conditional values that are directly involved in the calculations to assess the incidence of changes in the values of exposures on the deviation of the effective indicator.

And this means that the accuracy of the values of exposures and imputations in general depends on the results of factor analysis, which are necessary for the development and justification of various management decisions.

The optimal importance of exposures will significantly reduce the number and volume of computational procedures and at the same time obtain objective results of factor analysis [Fedoskin, and Kalmykova,2012, Byshov, et al, 2018].

Materials and methods

In order to substantiate the optimal accuracy of intermediate results in assessing the influence of exposures on the effective indicator, a multiplicative factor model of the gross crop production from various types of agricultural land was used.

This is due to the fact that the production of gross crop production (for the compatibility of various types of products, their volume is calculated in fodder units) per 100 hectares of agricultural land is one of the main economic indicators used to assess the effectiveness of using main types of land (arable land, grasslands and pastures) [Byshov,et al, 2018].

Currently, enterprises of the agro-industrial complex engaged in crop and livestock production often experience changes both in the total size of the land area and in the sizes of areas of the main types of agricultural land (arable land, hayfields and pastures) where various types of products are grown. In addition, there are changes in the structure of lands and their productivity (output of products from 1 ha). And this, of course, directly affects the level of crop gross yield [Fedoskin, and Kalmykova, 2013].

Therefore, there is a need to assess the incidence of these factors on the yield of crop production.

Based on the foregoing, it can be concluded that the crop gross yield (GY) as a productive indicator directly depends on the following exposures: the size of the area of agricultural land (by type), their share (structure) and productivity.

Consequently, the volume of gross yield, as shown above, can be represented as the following factor model:

$GY = \sum(S^{total} : 100 * RS^{j}) * P^{j}$ or

$GY = \sum(S^{total} * RS^{j}) :100 * P^{j}$.

The volume of crop gross crop yield consists of products obtained from various types of agricultural land.

So, on arable land products of various crops are grown: grain, potatoes, sugar beets, fodder beets, hay of perennial and annual grasses, green mass of annual and perennial grasses for feed and for the production of haylage, etc.

From the area of haymaking one gets hay and green mass for animal feed. On pastures, as a rule, the green grass is fed when grazing the livestock [Fedoskin, and Kalmykova, 2013]. Thus, all types of products obtained in the physical mass are heterogeneous.

Therefore, to determine the actual crop yields from various types of agricultural land and total gross crop production (Table 1), each type of product is converted from the physical mass to feed units based on the coefficients of the feed units in the physical mass of each type of product.

Table 1 – Areas of agricultural land, their productivity and the actual gross yield

Types of agricultural land	Plan (2013)			Fact (2017)		
	Area, ha	Gross yield, c.f.u.	Productivity of 1 ha, c.f.u.	Area, ha	Gross yield, c.f.u.	Productivity of 1 ha, c.f.u.
Arable land	1930	95,987.51	49.73446	2,210	115,846.50	52.41923
Hay acreage	800	7,628.41	9.53551	1,000	26,710.14	26.71014
Pastures	920	14,200.08	15.43487	1,002	17,884.36	17.84866
Total	3650	117,816.00	15.43487	4,212	160,441.00	38.09141

The above factor model of crop gross yield is used if the share of certain types of agricultural land is expressed as a percentage.

The part of the factor model $[(S^{total} : 100 * RS^{j})]$ or $[(S^{total} * RS^{j}) :100]$ allows determining the area of each type of agricultural land when numerical values are inserted into the factor model with the purpose of its interpretation [Kalmykov, et al, 2017].

Thus, the area of agricultural land by type (based on the data in Table 1) when decoding the factor model will be (the share of each type of land is calculated to the 1st decimal mark — one decimal mark):

а) arable land: $(S^{total} : 100 * RS^{j})$ = 3,650 ha : 100 * 52.9 % = 1,930.85 ha;

б) hay acreage: $(S^{total} : 100 * RS^{j})$ = 3,650 ha : 100 * 21.9 % = 799.35 ha;

в) pastures: $(S^{total} : 100 * RS^{j})$ = 3,650 ha : 100 * 25.2 % = 919.80 ha.

As can be seen from the calculations, the obtained values of land areas differ from the actual, which will certainly affect the objectivity and reliability of the results of factor analysis.

Assessment of the incidence of exposures on the effective indicator when there are structural indicators in the model, as already noted above, is carried out only using the method of chain substitutions.

And for this, it is necessary to make the transition from the plan model (2013) to the fact (2017) by successive replacement of the planned values of exposures with the actual indicators. In the process of such a replacement, it becomes necessary to calculate conditional values (Table 2), in the factor models of which (as well as in the planned and actual) indicators such as land area, their share and productivity of individual types of agricultural land are intermediate results.

A natural question arises: with what accuracy (the number of decimal marks after the comma) are intermediate results necessary for an objective assessment of incidence of exposures on the effective indicator.

It should be noted that the more decimal marks in intermediate results are present, the more accurate the final results are.

But for manual calculations (that is, without using personal computers with software), for the convenience of factor analysis it is necessary to limit oneself to the most optimal number of decimal marks that can be established experimentally.

Let's show it by the following example.

Variant 1. The share of agricultural land and the productivity of 1 hectare as intermediate results are calculated with an accuracy of one decimal mark (Table 2).

In this case, when substituting the numerical values of indicators into the factor model, we obtain the gross yield in the amount of 117,721.99 c.f.u. (which is less than the actual level of 2013 by 94.01 c.f.u. - Table 4), including those from the area:

а) of arable land: $(S_p^{total} : 100 * RS_p^{j}) * P_p^{j}$ = 3,650 ha : 100 * 52.9 % * 49.7 c.f.u. = 36.50 ha * 52.9 % * 49.7 c.f.u. = 1,930.85 ha * 49.7 c.f.u. = 95,963.245 c.f.u.t;

б) of hay acreage: $(S_p^{total} : 100 * RS_p^{j}) * P_p^{j}$ = (3,650 ha : 100) * 21.9 % * 9.5 c.f.u. = 36.50 ha * 21.9 % * 9.5 c.f.u. = 799.35 ha * 9.5 c.f.u. = 7,593.825 c.f.u.;

в) of pastures: $(S_p^{total} : 100 * RS_p^{j}) * P_p^{j}$ = (3,650 ha : 100) * 25.2 % * 15.4 c.f.u. = 36.50 ha * 25.2 % * 15.4 c.f.u. = 919.80 ha * 15.4 c.f.u. = 14,164.92 c.f.u.

Thus, as a result of decoding the factor model, the calculated values of agricultural land areas differ from the actual values in 2013 (Table 4), although their sum exactly corresponds to the actual availability:

1,930.85 ha +799.35 ha + 919.80 ha = 3,650 ha

The estimated volume of crop gross yield, both from individual types of agricultural land, and in general was lower than its actual level in 2013 (Table 4).

95,963.245 c.f.u. +7,593.825 c.f.u. + 14,164.92 c.f.u. = 117,721.99 c.f.u.

Table 2 - The composition and structure of agricultural lands and their productivity

Types of agricultural land	Yield from 1 ha of land, centner of fodder unit		Composition and structure of agricultural lands			
	Plan (2013)	Fact (2017)	Plan (2013)		Fact (2017)	
	P_p	P_f	S_p (ha)	RS_p (%)	S_f (ha)	RS_f (%)
Variant 1 (1 decimal mark)						
Arable land	49.7	52.4	1,930	52.9	2,210	52.5
Hay acreage	9.5	26.7	800	21.9	1,000	23.7
Pastures	15.4	17.8	920	25.2	1,002	23.8
Total	X	X	$\sum S_p^{total}$ = =3,650	100.0	$\sum S_f^{total}$ = =4,212	100.0
At average	32.3	38.1	X	X	X	X
Variant 2 (2 decimal marks)						
Arable land	49.73	52.42	1,930	52.88	2,210	52.47
Hay acreage	9.54	26.71	800	21.92	1,000	23.74
Pastures	15.43	17.85	920	25.20	1,002	23.79
Total	X	X	$\sum S_p^{total}$ = =3,650	100.0	$\sum S_f^{total}$ = =4,212	100.0
At average	32.28	38.10	X	X	X	X
Variant 3 (3 decimal marks)						
Arable land	49.734	52.419	1,930	52.877	2,210	52.469
Hay acreage	9.536	26.710	800	21.918	1,000	23.742
Pastures	15.435	17.849	920	25.205	1,002	23.789
Total	X	X	$\sum S_p^{total}$ = =3,650	100.0	$\sum S_f^{total}$ = =4,212	100.0
At average	32.278	38.091	X	X	X	X
Variant 4 (4 decimal marks)						
Arable land	49.7345	52.4192	1,930	52.8767	2,210	52.4691
Hay acreage	9.5355	26.7101	800	21.9178	1,000	23.7417
Pastures	15.4349	17.8487	920	25.2055	1,002	23.7892
Total	X	X	$\sum S_p^{total}$ = =3,650	100.0	$\sum S_f^{total}$ = =4,212	100.0
At average	32.2784	38.0914	X	X	X	X
Variant 5 (5 decimal marks)						
Arable land	49.73446	52.41923	1,930	52.87671	2,210	52.46914
Hay acreage	9.53551	26.71014	800	21.91781	1,000	23.74169
Pastures	15.43487	17.84866	920	25.20548	1,002	23.78917
Total	X	X	$\sum S_p^{total}$ = =3,650	100.0	$\sum S_f^{total}$ = = 4,212	100.0
At average	32.27836	38.09141	X	X	X	X

Although the area of arable land as the most productive type of land turned out to be 0.85 hectares more than actual, but the calculated gross yield turned out to be less than the actual because of insufficient accuracy of productivity of 1 hectare, the value of which was used with an accuracy of one decimal mark.

This determined the difference in size (-94.010 c.f.u.) (Table 5) between the actual volume of the product obtained (117,816.00 c.f.u.) and the calculated one (117,721.99 c.f.u.).

Table 3 – Gross yield from the areas calculated by factor models with different accuracy of the values of exposures

Types of agricultural land	Gross yield, centner to unit			
	Plan (2013) $S_p^{total}:100*RS^j_p*P^j_p$	Cond. 1 $S_f^{total}:100*RS^j_p*P^j_p$	Cond. 2 $S_f^{total}:100*RS^j_f*P^j_p$	Fact (2017) $S_f^{total}:100*RS^j_f*P^j_f$
Variant 1 (1 decimal mark)				
Arable land	95,963.245	110,738.956	109,901.610	115,872.12
Hay acreage	7,593.825	8,763.066	9,483.318	26,653.115
Pastures	14,164.920	16,345.930	15,437.822	17,843.717
Total	117,721.990	135,847.952	134,822.750	160,368.952
Variant 2 (2 decimal marks)				
Arable land	95,984.868	110,763.907	109,905.110	115,850.108
Hay acreage	7,632.763	8,808.000	9,539.321	26,708.098
Pastures	14,192.514	16,377.772	15,461.397	17,886.321
Total	117,810.145	135,949.679	134,905.828	160,444.527
Variant 3 (3 decimal marks)				
Arable land	95,987.142	110,766.532	109,911.856	115,845.690
Hay acreage	7,628.867	8,803.503	9,536.124	26,710.348
Pastures	14,199.930	16,386.330	15,465.757	17,884.567
Total	117,815.939	135,956.365	134,913.737	160,440.605
Variant 4 (4 decimal marks)				
Arable land	95,987.563	110,767.017	109,913.170	115,846.353
Hay acreage	7,628.397	8,802.961	9,535.504	26,710.111
Pastures	14,200.109	16,386.549	15,465.787	17,884.417
Total	117,816.069	135,956.527	134,914.461	160,440.881
Variant 5 (5 decimal marks)				
Arable land	95,987.504	110,766.949	109,913.165	115,846.508
Hay acreage	7,628.409	8,802.975	9,535.510	26,710.140
Pastures	14,200.081	16,386.504	15,465.737	17,884.354
Total	117,815.994	135,956.428	134,914.412	160,441.002

When replacing in the factor model the value of the total agricultural land from the planned (2013) to the actual (2017) one, the first conditional crop gross yield is calculated (Table 3):

$GY_{COND.\ 1} = \sum[(S_F^{\ total} : 100 * RS_p^{\ j}) * P_p^{\ j}]$ = 4,212 ha : 100 * 52.9 % * 49.7 c.f.u. + 4,212 ha : 100 * 21.9 % * 9.5 c.f.u. + 4,212 ha : 100 * 25.2 % * 15.4 c.f.u. = 110,738.956 c.f.u. + 8,763.066 c.f.u. + 16,345.930 c.f.u. = 135,847.952 c.f.u.

With the introduction of the actual value of the second exposure ($RS_F^{\ j}$) in the factor model the second conditional gross yield of crop production is determined:

$GY_{COND.\ 2} = \sum[(S_F^{\ total} : 100 * RS_F^{\ j}) * P_p^{\ j}]$ = 4,212 ha : 100 * 52.5 % * 49.7 c.f.u. + 4,212 ha : 100 * 23.7 % * 9.5 c.f.u. + 4,212 ha : 100 * 23.8 % * 15.4 c.f.u. = 109,901.610 c.f.u. + 9,483.318 c.f.u. + 15,437.822 c.f.u. = 134,822.750 c.f.u.

Table 4 – Deviations of the calculated values of agricultural land from the actual ones

Variants of calculating the specific share of certain types of agricultural lands	Year	Estimated values of agricultural lands above (+) or below (-) the actual level, ha			
		Arable land	Hay acreage	Pastures	Total
Variant 1 (1 decimal mark)	2013	+0.85	-0.65	-0.20	-
	2017	+1.300	-1.756	+0.456	-
Variant 2 (2 decimal marks)	2013	+0.12	+0.08	-0.20	-
	2017	+0.0364	-0.0712	+0.0348	-
Variant 3 (3 decimal marks)	2013	+0.0105	+0.0070	-0.0175	-
	2017	-0.00572	+0.01304	-0.00732	-
Variant 4 (4 decimal marks)	2013	-0.00045	-0.0003	+0.00075	-
	2017	-0.001508	+0.000404	+0.001104	-
Variant 5 (5 decimal marks)	2013	-0.000085	+0.000065	+0.00002	-
	2017	+0.0001768	-0.0000172	+0.0001596	-

By introducing the actual value of the third exposure into the factor model, we obtain the following type of it and the calculated values of the gross yield:

$GY_F = \sum[(S_F^{total} : 100 * RS_F^{\,j}) * P_{PF}^{\,j}]$ = 4,212 ha : 100 * 52.5 % * 52.4 c.f.u. + 4,212 ha : 100 * 23.7 % * 26.7 c.f.u. + 4,212 ha : 100 * 23.8 % * 17.8 c.f.u. = 2,211.3 ha * 52.4 c.f.u. + 998.244 ha * 26.7 c.f.u. + 1,002.456 ha * 17.8 c.f.u. = 115,872.12 c.f.u. + 26,653.115 c.f.u. + 17,843.717 c.f.u. = 160,368.952 c.f.u.

Table 5 – Deviations of the calculated gross yield from the area of agricultural lands from the actual one

Variants of calculating the specific share of certain types of agricultural lands	Year	Estimated values of gross yield above (+) or below (-) the actual level, centner to unit			
		Arable land	Hay acreage	Pastures	Total
Variant 1	2013	-24.265	-34.585	-35.16	-94.010
(1 decimal mark)	2017	+25.62	-57.025	-40.643	-72.048
Variant 2	2013	-2.642	+4.353	-7.566	-5.855
(2 decimal marks)	2017	+3.608	-2.042	+1.961	+3.527
Variant 3	2013	-0.368	+0.457	-0.150	-0.061
(3 decimal marks)	2017	-0.810	+0.208	+0.207	-0.395
Variant 4	2013	+0.053	-0.013	+0.029	+0.069
(4 decimal marks)	2017	-0.147	-0.029	+0.057	-0.119
Variant 5	2013	-0.006	-0.001	+0.001	-0.006
(5 decimal marks)	2017	+0.008	0.000	-0.006	+0.002

Variant 2. The share of agricultural land and productivity of 1 hectare as intermediate results are calculated with an accuracy of two decimal marks (Table 2).

In this case, when substituting the numerical values of indicators into the factor model, we obtain the crop gross yield in the amount of 117,810.145 centner of fodder unit (which is lower than the actual level of 2013 by 5.855 c.f.u. - Table 4):

$GY_P = \sum[(S_P^{total} : 100 * C_P^{\,j}) * P_P^{\,j}]$ = 3,650 ha : 100 * 52.88 % * 49.73 c.f.u. + 3,650 ha : 100 * 21.92 % * 9.54 c.f.u. + 3,650 ha : 100 * 25.20 % * 15.43 c.f.u. = 1,930.12 ha * 49.73 c.f.u. + 800.08 ha * 9.54 c.f.u. + 919.8 ha * 15.43 c.f.u. = 95,984.868 c.f.u. + 7,632.763 c.f.u. + 14,192.514 c.f.u. = 117,810.145 c.f.u.

Thus, as a result of decoding the factor model, the calculated values of agricultural land areas differ from their actual values in 2013 (Table 4), although less significantly than in the first variant.

The estimated yield of products differs less significantly from the actual values of 2013 (Table 5).

$GY_{COND.\,1} = \sum[(S_F^{total} : 100 * RS_P^{\,j}) * P_P^{\,j}]$ = 4,212 ha : 100 * 52.88 % * 49.73 c.f.u. + 4,212 ha : 100 * 21.92 % * 9.54 c.f.u. + 4,212 ha : 100 * 25.20 % * 15.43 c.f.u. = 110,763.907 c.f.u. + 8,808.000 c.f.u. + 16,377.772 c.f.u. = 135,949.679 c.f.u.

With the introduction of the actual value of the second exposure ($C_Ф^{\,j}$) into the factor model the second conditional crop gross yield is determined:

$GY_{COND.\,2} = \sum[(S_F^{total} : 100 * RS_F^{\,j}) * P_P^{\,j}]$ = 4,212 ha : 100 * 52.47 % * 49.73 c.f.u. + 4,212 ha : 100 * 23.74 % * 9.54 c.f.u. + 4,212 ha : 100 * 23.79 % * 15.43 c.f.u. = 109,905.110 c.f.u. + 9,539.321 c.f.u. + 15,461.397 c.f.u. = 134,905.828 c.f.u.

When introducing the actual value of the third exposure into the factor model, one gets the following model and the values of gross yield:

$GY_F = \sum[(S_F^{total} : 100 * RS_F^{\,j}) * P_{PF}^{\,j}]$ = 4,212 ha : 100 * 52.47 % * 52.42 c.f.u. + 4,212 ha : 100 * 23.74 % * 26.71 c.f.u. + 4,212 ha : 100 * 23.79 % * 17,85 c.f.u. = 2,210.0364 ha * 52.42 c.f.u. + 999.9288 ha * 26.71 c.f.u. + 1,002.0348 ha * 17.85 c.f.u. = 115,850.108 c.f.u. + 26,708.098 c.f.u. + 17,886.321 c.f.u. = 160,444.527 c.f.u.

The calculated values of land areas obtained when using their relative share for 2017 with two decimal marks are much less different from the actual ones than in calculations with one decimal mark (Table 4).

The estimated crop gross yield is insignificantly (only by 3.527 c.f.u.) above the actual (Table 5).

Variant 3. The relative share of agricultural land and productivity of 1 hectare as intermediate results are calculated with an accuracy of three decimal marks (Table 2).

In this case, when substituting the numerical values of the indicators into the factor model, we obtain the crop gross yield in the amount of 117,815.939 c.f.u. (which is less than the actual level of 2013 by only 0.061 c.f.u. -

Table 4):

$GY_P = \sum[(S_P^{total} : 100 * RS_P^{\ j}) * P_P^{\ j}]$ = 3,650 ha : 100 * 52.877 % * 49.734 c.f.u. + 3,650 ha : 100 * 21.918 % * 9.536 c.f.u. + 3,650 ha : 100 * 25.205 % * 15.435 c.f.u. = 1,930.0105 ha * 49.734 c.f.u. + 800.007 ha * 9.536 c.f.u. + 919.9825 ha * 15.435 c.f.u. = 95,987.142 c.f.u. + 7,628.867 c.f.u. +14,199.930 c.f.u. = 117,815.939 c.f.u.

Thus, as a result of decoding the factor model, the calculated values of agricultural land areas differ from their actual values in 2013 (Table 4), although rather insignificantly than in the first and second variants. The estimated yield is also less significantly different from the actual values of 2013 (Table 5).

$GY_{COND.\ 1} = \sum[(S_F^{\ total} : 100 * RS_P^{\ j}) * P_P^{\ j}]$ = 4,212 ha : 100 * 52.877 % * 49.734 c.f.u. + 4,212 ha : 100 * 21.918 % * 9.536 c.f.u. + 4,212 ha : 100 * 25.205 % * 15.435 c.f.u. = 110,766.532 c.f.u. + 8,803.503 c.f.u. + 16,386.330 c.f.u. = 135,956.365 c.f.u.

When introducing the actual value of the second exposure ($RS_F^{\ j}$) into the factor model, one gets the crop gross yield of the second condition:

$GY_{COND.\ 2} = \sum[(S_F^{total} : 100 * RS_F^{\ j}) * P_P^{\ j}]$ = 4,212 ha : 100 * 52.469 % * 49.734 c.f.u. + 4,212 ha : 100 * 23.742 % * 9.536 c.f.u. + 4,212 ha : 100 * 23.789 % * 15.435 c.f.u. = 109,911.856 c.f.u. + 9,536.124 c.f.u. + 15,465.757 c.f.u. = 134,913.737 c.f.u.

By introducing the actual value of the third exposure into the factor model, we obtain the following type of it and the calculated values of the gross yield:

$GY_F = \sum[(S_F^{total} : 100 * RS_F^{\ j}) * P_{PF}^{\ j}]$ = 4,212 ha : 100 * 52.469 % * 52.419 c.f.u. + 4,212 ha : 100 * 23.742 % * 26.710 c.f.u. + 4,212 ha : 100 * 23.789 % * 17.849 c.f.u. = 2,209.99428 ha * 52.419 c.f.u. + 1,000.01304 ha * 26.710 c.f.u. + 1,001.99268 ha * 17.849 c.f.u. = 115,845.690 c.f.u. + 26,710.348 c.f.u. + 17,884.567 c.f.u. = 160,440.605 c.f.u.

The calculated values of land areas obtained using their relative share in 2017 and having three decimal marks are even less different from the actual ones than in calculations with two decimal marks (Table 4).

The estimated crop gross yield is only 0.395 c.f.u. below the actual one (Table 5).

<u>Variant 4.</u> The relative share of agricultural land and productivity of 1 hectare as intermediate results are calculated with an accuracy of four decimal marks (Table 2).

In this case, when substituting the numerical values of the indicators into the factor model, we obtain the gross yield in the amount of 117,816.069 c.f.u. (which is more than the actual level of 2013 by only 0.069 c.f.u. - Table 4):

$GY_P = \sum[(S_P^{\ total} : 100 * RS_P^{\ j}) * P_P^{\ j}]$ = 3,650 ha : 100 * 52.8767 % * 49.7345 c.f.u. + 3,650 ha : 100 * 21.9178 % * 9.355 c.f.u. + 3,650 ha : 100 * 25.2055 % * 15.4349 c.f.u. = 1,929.99955 ha * 49.7345 c.f.u. + 799.9997 ha * 9.5355 c.f.u. + 920.00075 ha * 15.4349 c.f.u. = 95,987.563 c.f.u. + 7,628.397 c.f.u. + 14,200.109 c.f.u. = 117,816.069 c.f.u.

As a result of decoding the factor model, the calculated values of agricultural land areas differ from their actual values in 2013 (Table 4) only by square meters:

a) the estimated area of arable land is less than the actual one by 4.5 square meters;

b) the estimated area of hay acreage is less than the actual one by 3 square meters;

c) the estimated pasture area is more than the actual one by 7.5 square meters.

In our opinion, such insignificant discrepancies can be neglected, if we consider that one hectare contains 10,000 square meters.

The estimated yield of products also differs slightly from the actual values of 2013 (Table 5): only by 0.069 c.f.u. or 6.9 kilograms of feed units.

$GY_{COND.\ 1} = \sum[(S_F^{\ total} : 100 * RS_P^{\ j}) * P_P^{\ j}]$ = 4,212 ha : 100 * 52.8767 % * 49.7345 c.f.u. + 4,212 ha : 100 * 21.9178 % * 9.5355 c.f.u. + 4,212 ha :100 * 25.2055 % * 15.4349 c.f.u. = 110,767.017 c.f.u. + 8,802.961 c.f.u.

+ 16,386.549 c.f.u. = 135,956.527 c.f.u.

When introducing the actual value of the second exposure (RS_F^j) into the factor model, one gets the crop gross yield of the second condition:

$GY_{COND.\,2} = \sum[(S_F^{total} : 100 * RS_F^j) * P_P^j]$ = 4,212 ha : 100 * 52.4691 % * 49.7345 c.f.u. + 4,212 ha : 100 * 23.7417 % * 9.5355 c.f.u. + 4,212 ha : 100 * 23.7892 % * 15.4349 c.f.u. = 109,913.170 c.f.u. + 9,535.504 c.f.u. + 15,465.787 c.f.u. = 134,914.461 c.f.u.

When introducing the actual value of the third exposure into the factor model, one gets the following model and the values of gross yield:

$GY_F = \sum[(S_F^{total} : 100 * RS_F^j) * P_{PF}^j]$ = 4,212 ha : 100 * 52.4691 % * 52.4192 c.f.u. + 4,212 ha : 100 * 23.7417 % * 26.7101 c.f.u. + 4,212 ha : 100 * 23.7892 % * 17.8487 c.f.u. = 2,209.998492 ha * 52.4192 c.f.u. + 1,000.000404 ha * 26.7101 c.f.u. + 1,002.001104 ha * 17.8487 c.f.u. = 115,846.353 c.f.u. + 26,710.111 c.f.u. + 17,884.417 c.f.u. = 160,440.881 c.f.u.

The calculated values of land areas obtained using their relative share for 2017 and having four decimal marks practically correspond to the actual ones, differing from them by an insignificant value (Table 4):

a) the estimated area of arable land is less than the actual one by 15.08 square meters;

b) the estimated area of hay acreage is more than the actual one by 4.04 square meters;

c) the estimated pasture area is more than the actual one by 11.04 square meters.

The estimated crop gross yield is only 0.119 c.f.u. below the actual one (Table 5).

<u>Variant 5.</u> The relative share of agricultural lands and productivity of 1 hectare as intermediate results are calculated with an accuracy of five decimal marks (Table 2).

In this case, when substituting the numerical values of the indicators into the factor model, one obtains the crop gross yield in the amount of 117,815.994 c.f.u. (which is less than the actual level of 2013 by only 0.006 c.f.u. - Table 4):

$GY_{ПР} = \sum[(S_P^{total} : 100 * RS_P^j) * P_P^j]$ = 3,650 ha : 100 * 52.87671 % * 49.73446 c.f.u. + 3,650 ha : 100 * 21.91781 % * 9.53551 c.f.u. + 3,650 ha : 100 * 25.20548 % * 15.43487 c.f.u. = 1,929.999915 ha * 49.73446 c.f.u. + 800.000065 ha * 9.53551 c.f.u. + 920.00002 ha * 15.43487 c.f.u. = 95,987.504 c.f.u. + 7,628.409 c.f.u. + 14,200.081 c.f.u. = 117,815.994 c.f.u.

As a result of decoding the factor model, the calculated values of the areas of agricultural land differ from their actual values in 2013, as well as in the fourth variant, only by square meters (Table 4):

a) the estimated area of arable land is less than the actual one only by 0.85 square meters;

b) the estimated area of hay acreage is more than the actual one by 0.65 square meters;

c) the estimated pasture area is more than the actual one by 0.20 square meters.

The discrepancies between the actual and estimated areas of agricultural land in this variant are already an order of magnitude smaller than in the fourth variant.

The calculated crop yield is also slightly different from the actual values of 2013 (Table 5): only 0.006 c.f.u. or 0.6 kilograms of feed units.

$GY_{COND.\,1} = \sum[(S_F^{total} : 100 * RS_P^j) * P_P^j]$ = 4,212 ha :100 * 52.87671 % * 49.73446 c.f.u. + 4,212 ha : 100 * 21.91781 % * 9.53551 c.f.u. + 4,212 ha : 100 * 25.20548 % * 15.43487 c.f.u. = 110,766.949 c.f.u. + 8,802.975 c.f.u. + 16,386.504 c.f.u. = 135,956.428 c.f.u.

When introducing the actual value of the second exposure (RS_F^j) into the factor model, one gets the crop gross yield of the second condition:

$GY_{COND.\,2} = \sum[(S_F^{total} : 100 * RS_F^j) * P_P^j]$ = 4,212 ha : 100 * 52.46914 % * 49.73446 c.f.u. + 4,212 ha : 100 * 23.74169 % * 9.53551 c.f.u. + 4,212 ha : 100 * 23.78917 % * 15.43487 c.f.u. = 109,913.165 c.f.u. + 9,535.510

c.f.u. + 15,465.737 c.f.u. = 134,914.412 c.f.u.

By introducing the actual value of the third exposure into the factor model, one obtains the following type of it and the calculated values of the gross yield:

$GY_F = \sum[(S_F^{total} : 100 * RS_F^{j}) * P_{PF}^{j}]$ = 4,212 ha : 100 * 52.46914 % * 52.41923 c.f.u. + 4,212 ha : 100 * 23.74169 % * 26.71014 c.f.u. + 4,212 ha : 100 * 23.78917 % * 17.84866 c.f.u. = 2,210.0001768 ha * 52.41923 c.f.u. + 999.9999828 ha * 26.71014 c.f.u. + 1,001.9998404 ha * 17.84866 c.f.u. = 115,846.508 c.f.u. + 26,710.140 c.f.u. + 17,884.354 c.f.u. = 160,441.002 c.f.u.

The calculated values of land areas obtained using their relative share in 2017 with five decimal marks practically correspond to the actual ones, differing from them by an insignificant amount (Table 4):

a) the estimated area of arable land is more than the actual one only by 1.768 square meters;

b) the estimated area of hay acreage is less than the actual one by 0.172 square meters;

c) the estimated pasture area is less than the actual one by 1.596 square meters.

The estimated crop gross yield is only 0.002 c.f.u. above the actual one (Table 5).

Results and discussion

The theoretical and methodological foundations of factor analysis are highlighted in the scientific studies of Russian and foreign authors, such as Sheremet A.D., Bakanov M.I., Gilyarovskaya L.T., Lysenko D.V., Bank V.R., Kovalev V.V., Savitskaya G.V., Hedderwik K., Helfert E. and others [Bakanov, et al, 2005; Bank, et al, 2012; Gilyarovskaya, et al, 2006; Kovalev, 2002; Savitskaya, 2017; Hedderwick,1996; Helfert, 2003; Sheremet, and Negashev, 2016].

Numerous scientific works of native and foreign authors present methods of factor analysis of economic indicators using various methods for assessing the incidence of exposures on the effective indicator.

However, in our opinion, insufficient attention in the practice of factor analysis is paid to the accuracy (the number of decimal marks after the comma) of intermediate results, which are exposures.

At the same time, the objectivity of the incidence of exposures on the change in the effective indicator depends largely on the accuracy of the exposure values.

It should be noted that in the works devoted to the issues of the method of factor analysis, it is at best mentioned that the more accurate the value of exposures, the more accurate the results of factor analysis. At the same time, the exact value (the number of decimal marks) of exposures is not indicated [Sheremet, and Negashev, 2016].

Based on this, we attempted to establish the optimal accuracy of exposures, since almost all of them in factor models are the results of intermediate calculations.

Comparative evaluation of the results of the above calculations allowed us to conclude that it is quite legitimate to calculate the exposure values with an accuracy of four decimal marks, which will allow to obtain fairly objective results when carrying out factor analysis (Table 6).

Table 6 – The incidence of the main factors on the crop gross yield with different accuracy of exposures

	The incidence on the effective indicator of changes (centner to unit) of				The total deviation of the gross yield (centner to unit) in	
	area	relative share	productivity	total	estimated data	fact sheet
Variant 1 (1 decimal mark)	+18,126.0	-1,025.2	+25,546.2	+42,647.0	+42,647.0	+42,625.0
Variant 2 (2 decimal marks)	+18,139.6	-1,043.9	+25,538.7	+42,634.4	+42,634.4	+42,625.0
Variant 3 (3 decimal marks)	+18,140.4	-1,042.6	+25,526.9	+42,624.7	+42,624.7	+42,625.0
Variant 4 (4 decimal marks)	+18,140.5	-1,042.1	+25,526.4	+42,624.8	+42,624.8	+42,625.0
Variant 5 (5 decimal marks)	+18,140.4	-1,042.0	+25,526.6	+42,625.0	+42,625.0	+42,625.0

It should be noted that with the accuracy of exposures with five decimal marks, the calculated deviation and the sum of the influence of the three factors fully coincide with the actual deviation [Byshov, et al, 2018; Zavgorodnyaya, et al, 2018].

In order to test and confirm these findings, factor analysis was carried out, but already using the method of calculating absolute differences, annual labor productivity.

Over the past five years, its level of labor productivity has increased quite significantly, as evidenced by the dynamics of the following indicators: annual labor productivity increased by 41.4 %, daily one - by 21.9 % and hourly productivity - by 17.1 % (Table 7).

It should be noted here that the change in the level of annual labor productivity is associated not only with an increase in the cost of goods produced and, accordingly, with an increase in hourly labor productivity, but also with a reduction in the number of days worked per year by one employee and a decrease in working hours.

In analytical calculations, it is generally accepted to represent any economic indicator in the form of a factor model.

On this basis, the annual labor productivity as a productive indicator can be represented as a multiplicative factor model:

ALP = D * WDD * HLP, where

D is the number of days worked per year by one employee, days;

WDD is the average working day duration, h;

HLP is the gross agricultural output per one man-hour (hourly labor productivity), rubles [Kalmykov, et al, 2017].

Table 7 – Labor productivity movements

	2013	2014	2015	2016	2017	2017 in % to 2013
The volume of gross agricultural production in value terms (in comp. prices of 1994), thousand rubles	2,153.0	2,381.9	2,564.9	2,453.4	2,329.0	108.2
Number of agricultural workers, persons	166	150	141	140	127	76.5
Worked out in agriculture:						
man-days	40,393	39,016	40,117	40,539	35,859	88.8
man-hours	287,954	284,243	277,156	280,025	265,877	92.3
Gross agricultural output (rubles) per:						
- 1 worker	12,969.88	15,879.33	18,190.78	17,524.29	18,338.58	141.4
- 1 man-day	53.30	61.05	63.94	60.52	64.95	121.9
- 1 man-hour	7.48	8.38	9.25	8.76	8.76	117.1

In the above model, the exposures (the number of days worked, the length of the working day duration and the hourly labor productivity) are intermediate when determining the effective indicator. Therefore, the final result, as well as the results of factor analysis, that is, the objectivity of the influence of exposure changes on the effective indicator depend on the degree of exposure values accuracy.

In order to conduct a comparative assessment of the results of the factor analysis, the exposure values were calculated with an accuracy of 2, 3, 4, and 5 decimal marks (marks after comma) (Table 8).

Using a multiplicative factor model, the annual labor productivity for 2013 and 2017 was calculated with different precision of exposures.

Table 8 – The impact of the importance of exposures on the estimated annual labor productivity

		Importance of exposures			
		2 marks	3 marks	4 marks	5 marks
2013	Number of days worked per year by one worker (D), days	243.33	243.331	243.3313	43.33131
	Working day duration (WDD), hour	7.13	7.129	7.1288	7.12881
	Hourly labor productivity (HLP), rubles	7.48	7.477	7.4769	7.47689
	Estimated annual labor productivity (EALP), rub.	12,977.37	12,970.40	12,969.88	12,969.88
	Actual annual labor productivity (AALP), rub.	12,969.88	12,969.88	12,969.88	12,969.88
	The estimated annual labor productivity is more (+), less (-) than the actual one, rub.	+7.42	+0.52	-	-
2017	Number of days worked per year by one worker (D), days	282.35	282.354	282.3543	282.35433
	Working day duration (WDD), hour	7.41	7.415	7.4145	7.41451
	Hourly labor productivity (HLP), rubles	8.76	8.760	8.7597	8.75969
	Estimated annual labor productivity (EALP), rub.	18,327.79	18,340.42	18,338.57	18,338.58
	Actual annual labor productivity (AALP), rub.	18,338.58	18,338.58	18,338.58	18,338.58
	The estimated annual labor productivity is more (+), less (-) than the actual one, rub.	-10.79	+1.84	-0.01	-

In order to obtain the most objective results of the factor analysis, the assessment of their incidence on the change in the effective indicator was carried out with different accuracy of the exposures.

Since there are rubles as units of measurement, implying the value of indicators with two decimal marks, calculations with one decimal mark do not make sense.

Accuracy of 2 decimal marks:

1. The impact of changes in the number of days worked:

$\Delta ALP^{D} = (D_{17} – D_{13}) * WDD_{13} * HLP_{13} = (282.35 - 243.33) * 7.13 * 7.48 = +2{,}081.03$ (rub.)

2. Impact of change in working day duration:

$\Delta ALP^{WDD} = (WDD_{17} - WDD_{13}) * D_{17} * HLP_{13} = (7.41 - 7.13) * 282.35 * 7.48 = +591.35$ (rub.)

3. Impact of changes in hourly labor productivity:

$\Delta ALP^{WDD} = (HLP_{17} - HLP_{13}) * D_{17} * WDD_{17} = (8.76 - 7.48) * 282.35 * 7.41 = +2{,}678.03$ (rub.)

The sum of the influence of 3 factors [(+2,081.03) + (+ 591.35) + (+ 2,678.03)] is 5,350.41 rubles, which is lower than the actual deviation by 18.29 rubles (Table 9).

Accuracy of 3 decimal marks:

1. The impact of changes in the number of days worked:

$\Delta ALP^{D} = (D_{17} – D_{13}) * WDD_{13} * HLP_{13} = (282.354 – 243.331) * 7.129 * 7.477 = +2{,}080.06$ (rub.)

2. Impact of change in working day duration:

$\Delta ALP^{WDD} = (WDD_{17} - WDD_{13}) * D_{17} * HLP_{13} = (7.415 – 7.129) * 282.354 * 7.477 = +603.79$ (rub.)

Table 9 – The impact of the accuracy of intermediate results on the incidence of exposures

	Значность факторных показателей			
	2 marks	3 marks	4 marks	5 marks
Deviation of the annual labor productivity of 2017 from 2013 (actual deviation), rub.	+5,368.70			
Deviation of the annual labor productivity of 2017 from 2013 due to the change, rub.:				
a) the number of days worked per year by one worker (D)	+2,081.03	+2,080.06	+2,079.98	+2,079.98
b) working day duration (WDD)	+591.35	+603.79	+603.15	+603.15
c) hourly labor productivity (HLP)	+2,678.03	+2,686.16	+2,685.56	+2,685.57
The cumulative effect of exposure changes on the deviation of the effective indicator, rub.	+5,350.41	+5,370.01	+5,368.69	+5,368.70
The cumulative effect of exposure changes on the deviation of the effective indicator is greater (+) or less (-) than the actual deviation, rub.	-18.29	+1.31	-0.01	-

3. Impact of changes in hourly labor productivity:

$\Delta ALP^{WDD} = (HLP_{17} - HLP_{13}) * D_{17} * WDD_{17} = (8.760 - 7{,}477) * 282.354 * 7.415 = +2{,}686.16$ (rub.)

The sum of the influence of 3 factors [(+2,080.06) + (+603.79) + (+2,686.16)] is 5,370.01 rubles, which is higher than the actual deviation by 1.31 rubles (Table 9).

Accuracy of 4 decimal marks:

1. The impact of changes in the number of days worked:

$\Delta ALP^{D} = (D_{17} – D_{13}) * WDD_{13} * HLP_{13} = (282.3543 – 243.3313) * 7.1288 * 7.4769 = +2{,}079.98$ (rub.)

2. Impact of change in working day duration:

$\Delta ALP^{WDD} = (WDD_{17} - WDD_{13}) * D_{17} * HLP_{13} = (7.4145 – 7.1288) * 282.3543 * 7.4769 = +603.15$ (rub.)

3. Impact of changes in hourly labor productivity:

$\Delta ALP^{WDD} = (HLP_{17} - HLP_{13}) * D_{17} * WDD_{17} = (8.7597 – 7.4769) * 282.3543 * 7.4145 = +2{,}685.56$ (rub.)

The sum of the influence of 3 factors [(+2,079.98) + (+603.15) + (+2,685.56)] is 5,368.69 rubles, which is lower than the actual deviation only by 0.01 rubles.

Accuracy of 5 decimal marks:

1. The impact of changes in the number of days worked:

$\Delta ALP^{D} = (D_{17} – D_{13}) * WDD_{13} * HLP_{13} = (282.35433 – 243.33131) * 7.12881 * 7.47689 = +2{,}079.98$ (rub.)

2. Impact of change in working day duration:

$\Delta ALP^{WDD} = (WDD_{17} - WDD_{13}) * D_{17} * HLP_{13} = (7.41451 – 7.12881) * 282.35433 * 7.47689 = +603.15$ (rub.)

3. Impact of changes in hourly labor productivity:

$\Delta ALP^{WDD} = (HLP_{17} - HLP_{13}) * D_{17} * WDD_{17} = (8.75969 – 7.47689) * 282.35433 * 7.41451 = +2{,}685.57$ (rub.)

The sum of the influence of 3 factors [(+2,079.98) + (+603.15) + (+2,685.57)] is 5,368.70 rubles, which corresponds to the actual deviation.

Conclusions

Native and foreign economists, covering the issues of methodology and methods of factor analysis, have developed and justified types of factor models, basic principles and rules for assessing the influence of exposures, which are the results of intermediate calculations in factor models, on the change in the effective indicator.

At the same time, there is no unambiguous opinion on the issue of the specific accuracy with which exposures should be used in factor models in order to obtain objective results of assessing their incidence on the effective indicator.

Based on this, we have attempted to experimentally substantiate the optimal value (the number of decimal marks after comma) of exposures.

Based on a comparative assessment of the results of analysis at various degrees of exposures, it is possible to make an unequivocal conclusion that the most objective degree of accuracy of the influence of exposures on the effective indicator one can be obtained by using them already with 4 decimal marks.

The most accurate results of the factor analysis will be obtained when indicators are used in the factor model with their accuracy of five decimal marks.

This is confirmed by the results of the factor analysis of changes in the crop gross yield (in centners of fodder units) from all areas of agricultural land and changes in the level of annual labor productivity.

When carrying out a factor analysis of changes in the crop gross yield, it was found that using the values of exposures with an accuracy of five decimal marks (five marks after the comma), the calculated crop gross yield differs from the actual one only by 0.006 c.f.u. and 0.002 c.f.u. (Table 5).

Based on the fact that the crop gross yield amounted to 117,816.00 c.f.u. in 2013 and 160,441.00 c.f.u. in 2017, it is reasonable to assume that these differences will not have any effect on the objectivity of the results of factor analysis.

The results of the factor analysis of changes in the level of annual labor productivity confirmed the findings.

As a result, it was revealed that the most accurate results were obtained using exposures calculated with an accuracy of up to 5 decimal marks. In 2013, the estimated annual labor productivity fully coincided with the actual one. In 2017, there were also no differences between the estimated annual labor productivity and the actual labor productivity (Table 8).

At the same time, the sum of the influence of the three exposures on the effective indicator exactly to the hundredth coincided with the actual deviation (Table 9), which indicates the complete objectivity of the exposures incidence on the effective indicator.

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