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IMPACT OF AGROCHEMICAL SERVICES ON PRODUCTIVITY IN AGRICULTURE.

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Abstract.

Today, the introduction of new economic subjects of agricultural clusters in the agriculture of Uzbekistan, the sector is turning from a raw material producing sector into an industrialized sector producing finished products. However, the high consumption of resources in the production of agricultural products, the extensive use of chemical preparations, on the one hand, causes the high cost of products, and on the other hand, causes additional energy consumption in the context of global climate change. Accordingly, the assessment of the effectiveness of chemical services provided in the agricultural sector allows to achieve high results by identifying the factor that has the greatest influence on the resulting factor. Also, the use of econometric methods in the evaluation of factors affecting productivity allows not only to evaluate the influence of factors, but also to obtain high results in the future. As a result of intensive use of chemical fertilizers used in agriculture, not only high productivity is achieved, but also reduction of the impact on climate change. At the same time, taking into account that chemical fertilizers used in the production of agricultural products have a serious impact on human health, alternative use of them will also have a positive effect on human health.

Introduction.

Today, the effectiveness of providing agrochemical services is very important in the cultivation, care and pest control of agricultural crops. On the one hand, this affects the productivity of the produced products and their cost, and on the other hand, the quality of the produced products directly depends on the quality of agrochemical services. Agricultural entities operating in our republic are farms, farms and clusters. When analyzing the production potential of these economic entities, a large part of their total expenditure1 provides agrochemical services. Development of the republic economy and ensuring food safety are directly dependent on agriculture. Let's take note of GDP that the production of agricultural volumes is larger than other sectors which it shares

[1] Tabaev A.Z. Ways to increase the economic efficiency of providing agrochemical services to farms //Agroeconomics: integration of education, science and production: a collection of conference papers. - ToshDAU, 2007. - pp. 51-54.

of 32 % on GDP, accordingly we can say that the agricultural sector is the most important to our republic economy. At the same time, accounting to large part of people live in the countryside that their lifestyle is also related to agricultural desk. The big part of population is producing agricultural commodities on their household so like these population is influencing market prices in the future[2].

In fact, the effectiveness of the provided agrochemical services depends on several factors. Firstly, the services of delivering mineral fertilizers and chemical agents to agricultural enterprises, secondly, the state of storage of mineral fertilizers and chemical agents, and thirdly, the level of mechanization of providing agrochemical services are the most important factors.

According to researches, 4.2 million hectares of arable land are used in the agriculture of our republic today. Also, agrochemical activities are carried out on all lands used for agricultural purposes. Also, if we take into account that agrochemical activities are carried out in all regions of our republic in order to fight against various pests, we can understand how urgent it is to improve the sector. If we take into account the annual consumption of 400-500 kg of mineral fertilizers for only cotton and grain fields, we can understand how much material and labor resources are spent in the field.

In fact, it is impossible to ensure high productivity in today's agriculture without agrochemicals. However, the expansion of agrochemical services, on the one hand, requires an increase in the volume of production of mineral fertilizers and chemicals, and on the other hand, it also increases the demand for agricultural machinery. This increases the negative impact on ecology and the environment in the context of global climate change.

The effectiveness of agrochemical services can be seen in several processes. The first: if the chemical means used are carried out at the lowest cost of fertilization. The second is how much of the applied fertilizer actually reaches the plants. Also, the use of mineral fertilizers in agriculture not only increases the productivity of plants, but also various chemical preparations are used to protect them from pests. As a result of the high efficiency of pesticides, a high yield in agriculture is guaranteed, along with the reduction of various pests. Also, most chemical preparations are used against pests that are dangerous for humans[3].

In most developing countries, the rules for proper handling of mineral fertilizers and chemicals are not followed. This is because agrochemical activities are not highly mechanized and the processes of chemical feeding of agricultural crops are simultaneous. First of all, short-term spraying of chemical fertilizers is considered important. When using chemical pesticides, first of all, it is necessary to take into account their impact on the environment, as well as the used chemical

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[2] Bekzod Djuraev. Prediction of prices for agricultural products through markov chain model. International Journal of Psychosocial Rehabilitation, Vol. 24, Issue 03, 2020 ISSN: 1475-7192

[3] Cuervo-Parra, A.J., Cortés, R.T., Ramirez-Lepe, M., 2016. Mosquito-borne diseases, pesticides used for mosquito control, and development of resistance to insecticides. In: Trdan, Stanislav (Ed.), Insecticides Resistance, Edited volume IntechOpen https://doi.org/10.5772/61510. extracted on 24 June 2020 Chapter 7.

pesticides should be implemented in accordance with international norms, including the requirements developed by FAO, WHO, EU[4].

In fact, agriculture is a very labor-intensive sector with a large environmental impact, as well as the industry's largest source of raw materials. Agricultural production is subject to many uncontrollable risks, as production is directly dependent on natural factors and is affected by factors such as the complexity of achieving expected yields as a result of climate change[5].

Today, ensuring global food security is one of the main problems of all countries. This is directly related to the productivity of agricultural crops. Therefore, effective and timely implementation of agrochemical measures, on the one hand, creates the basis for increasing productivity, and on the other hand, it allows to save on chemical fertilizers. Today, the chemical fertilizers used in agriculture are not completely absorbed by the plant body. Because in traditional fertilization only certain parts of the field are planted, while fertilization is carried out in the whole field.

According to research, it is very difficult to achieve such high efficiency in agriculture without agrochemical measures. Through the widespread use of agrochemical fertilizers, not only the profitability of farmers, but also the reduction of the impact on the environment is achieved through the intensification of production. Intensive use of land resources, on the one hand, increases the production of food products, and on the other hand, a reduction of additional resources is achieved[6]. Because as a result of intensive use of land, the areas of pest control are also reduced.

Also, by using a stochastic model in the evaluation of the efficiency of agrochemical services, together with the statistics of the performance results of parameters in technical service, it is possible to determine the inadequate characteristics of the errors accepted in traditional production functions[7].

2. Materials andmethods.

When studying the use of chemical fertilizers by farmers, all economic regions of the republic were studied, taking into account the climate, soil fertility and other factors of production. However, it should not be forgotten that 90 percent of the food products in consumer markets are produced by small-scale households and farmers. As a result, determining the effectiveness of agrochemical measures is significantly more complicated.

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There are several models for determining efficiency, and the advantage of the stochastic model is that it allows to estimate the effect of factors that affect production, but are independent of farms, on the resulting indicator[8].

Therefore, in the stochastic model, it is possible to evaluate the impact of factors that affect the production result, but are not related to farms. In the research of Koyelli and his colleagues, the random variables of the stochastic model are bounded by exp $exp\ (X_i\beta + V_i)$. At the same time, because the random error V_i can be positive or negative to the resulting sign, the deterministic part of the constructed model of the stochastic threshold can differ sharply depending on $exp(X_i\beta)$.

In fact, the stochastic model is expressed in the following form:

$$Y_i = f(x_i\beta)exp(V_i - U_i)$$

In here Y_i- indicates total production volume, (i=1,2,…..,n);

X_i – vector of factors affecting production *(1*k)*;

β – *(1*k)* vector whose impact on production should be evaluated;

V_i – is a factor affecting production and is more related to natural conditions $\{N(0, \vartheta_v^2)\}$;

U_i- are natural factors that do not have a negative impact on production, and evaluate unused technical opportunities in production.

Through the constructed stochastic model, it is possible to distinguish relatively ineffective factors between $U_i$and V_i that have a negative impact on production.

Through the functions $Y_i = f(x_i\beta)$ and $exp(V_i - U_i)$, deterministic and stochastic relationships of the use of agrochemicals in agriculture are determined. At the same time, the value of factors U_i, which are relatively ineffective or of little economic benefit in the organization of agrochemical services, is calculated as follows;

$$U_i = \mathrm{Z}_i\delta + W_i$$

Бу ерда:

Z_i – vector of *(nx1)* variables that may affect the efficiency of the i th farm;

δ – vector of agrochemical measures *(px1)* to be evaluated;

W_i – are variables that are not included in the results of observation and research (affecting agrochemical activities), and in the model their value is zero and correlated with the unknown variance δ.

In fact, the correct and rational use of natural resources in agriculture, on the one hand, increases soil fertility, and on the other hand, reduces the consumption of chemical fertilizers that should be used. For example, if the correct organization of the crop rotation system on the land ensures the accumulation of additional fertilizers in the soil, the rational use of water and irrigation systems improves the melioration of the soil. Both factors have a significant impact on agrochemical cost savings.

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[8] BATTESE, G.E.; COELLI, T.J. A Model for Technical Inefficiency Effects in a Stochastic Frontier Production Function for Panel Data. *Empirical Economics*, v. 20,p. 325- 332, 1995

The technical efficiency (TE_i) of agrochemical management in agriculture is determined as follows for each farm i;

$$TE_i = Y/Y_i^* = \frac{Y_i}{exp(X_i\beta + V_i)} = exp(-U_i)$$

Stochastic assessment of the effectiveness of agrochemical measures in agriculture with maximum probability allows to determine the upper and lower limits of the expected result under the influence of chemical measures used in the field. Also, the parameters of the functions $\sigma\sigma^2 = \vartheta_u^2 + \vartheta_v^2$ and $\gamma = \vartheta_u^2/\vartheta_v^2$include the values of β.

In this case, the error variance of the function is determined in the interval from zero to one. In this function, σ^2 is the sum of the error variance, and as $\gamma = 0$ approaches, inefficiency also decreases, but as $\gamma = 0$ values increase from zero, the efficiency coefficient of chemical services in production also decreases. However, when $\gamma = 1$, two different; refers to the concept, the first is due to the fact that the factors affecting the efficiency of agrochemical measures are incorrectly selected, or the natural factors that directly affect production are estimated due to a large error.

In agro-industrial countries specializing in the production of agricultural products, the correct estimation of the stochastic limit of efficiency assessment, on the one hand, plays an important role in determining the perspective of the agricultural sector, and on the other hand, it allows to determine how production factors affect efficiency. Depending on the effect of factors on efficiency in the implementation of agrochemical activities in agriculture, it is possible to optimize the system of providing chemical services. As a result, it becomes possible to reduce the costs of agrochemical activities.

In the agricultural sector, stochastic evaluation requires logarithmic analysis of more production processes in determining the limit of influence of more factors on production efficiency. In this case, it is appropriate to use the Cobba Douglas production function. In the study, the maximum estimation method was used in the estimation of stochastic parameters. Variables representing the level of inefficiency are included in the determination of technical efficiency in agrochemical activities. Logarithmic analysis of the maximum likelihood ratio used to test the Cobb-Douglas function translog found that the efficiency threshold of agrochemical measures was suitable for the analyzed data.

The empirical version of the developed model is calculated as follows, expressing the limit of the trans-logarithmic effect of agrochemical measures.

$$ln\Upsilon_i = \beta_0 + \sum_{j=1}^{n} \beta_j ln\mathrm{X}_{ji} + \sum_{j=1}^{n} \sum_{k=1}^{n} \beta_{jk} ln\mathrm{X}_{ji} ln\mathrm{X}_{ki} + v_i + u_i$$

In here:

Υ_i – productivity of agricultural products;

X_1- equipment costs for agrochemical activities required per hectare;

X_2- consumption of chemical fertilizers required during the vegetation period;

X_3- irrigation costs (fees for water consumers, water saving technologies, maintenance of irrigation facilities and costs of water discharge facilities);

X_4- labor and other technical costs.

Date analysis.

The most cultivated cotton plant was selected from agricultural crops and the factors affecting it were analyzed (Table 1).

In determining the variables affecting the production result, it is of great importance to determine the factors affecting the technical indicators in the first place.

Also, specific variables that do not directly affect the efficiency of the farms of the studied Syrdarya region, such as $U_i = Z_i\delta + W_i$, were introduced.

These are:

Z_1 – farm size (total cotton area);

Z_2 – age of the head of the household;

Z_3- the experience of the farm manager in cotton cultivation;

Z_4- income from other sectors of the farm.

Table 1. Variable factors and general statistics for the empirical model in determining the effectiveness of agrochemical measures.

The name of the variable	Indicators	Unit of measure	General statistics		
			for 1 hectare	Minimum	Maximum
External and internal variables					
Y	Gross cotton yield	c/ha	30	24	36
X_1	Consumption of chemical fertilizers	Thousand sums UZS/ha	2977,4	2208,31	3106,5
X_2	The price of pesticides (sprayed and sprayed).	Thousand sums UZS/ha	73,2	74,6	77,4
X_3	The cost of irrigation systems	Thousand sums UZS/ha	1300	1100	1453
X_4	Labor cost	Thousand sums UZS/ha	1000	900	1100
X_5	The cost of techniques	Thousand sums UZS/ha	1239	1053,9	1363,8
Private variables of farms					

Z_1	Land area (size) of farms	hectares	70,8	42,4	127,4
Z_2	Age of the head of the farm	Years	45,3	25,7	62,3
Z_3	Work experience of the head of the farm	years	14,8	3,8	19,8
Z_4	Earnings in other networks	Yes or no yes=1; no=0	0,22	0	1

According to the conducted research, the organization of agrochemical services of cotton farms and its effectiveness were analyzed (Table 1). According to him, when the average yield in farms was 30 centners, chemical fertilizers worth 2977.4 thousand soums were used per hectare, but to increase the yield to 6 centners, additional chemical fertilizers worth 39.1 thousand soums per hectare were used. Also, the use of chemical pesticides increased productivity by 5 percent. However, this increase in productivity is not only due to the dependence on chemical services, but also due to natural factors and the intensification of production, natural reduction of pests.

The coefficients of the data production function in Table 1 were evaluated in the STATA program and the inefficiency threshold was determined for factors that were relatively inefficient in the translogorithmic production function, and the thresholds for factors that were inefficient in the implementation of agrochemical measures were determined. Based on the results of the analysis, the test hypotheses are presented in Table 2. These results are evaluated using a likelihood ratio test.

$$\gamma = -2\{Ln[L(H_0)] - Ln[L(H_1)]\}$$

Here: $L(H_0)$ and $L(H_1)$ represent the zero probability function of H_0 and its alternative H_1.
In our republic, cotton is grown in all regions. If we pay attention to the process of cotton cultivation, it was observed that the agrotechnology of cotton cultivation differs from one region to another, mostly due to natural climatic aspects. It should not be forgotten that differences in the technology of cotton cultivation between regions are not so different from each other. Due to the high salinity of the soil in the Khorezm region and the Republic of Karakalpakstan, there is a slight difference in the cultivation technology of pakha. Accordingly, the farms selected for the study were taken from all regions. A total of 189 farms. In order to assess the level of influence of factors on the process of providing chemical services in agrochemical activities to achieve high efficiency in agriculture, the logarithmic values of the data given in Table 1 were calculated using the STATA program (Table 2).

Table 2. Logarithmic analysis of factors

External and internal variables affecting the provision of agrochemical services			
LnY	3,40	3,17	3,58
X_1	7,99	7,69	8,04
X_2	4,29	4,31	4,34
X_3	7,17	7,01	7,28
X_4	6,91	6,8	7,00
X_5	7,12	6,96	7,21
Private variables affecting the provision of agrochemical services			
Z_1	4,25	3,74	4,84
Z_2	3,81	3,24	4,13
Z_3	2,69	1,33	2,98
Z_4	-1,51	-	0

When these factors with logarithmic values are stochastically analyzed, the factors that directly affect the production process in the application of agrotechnical measures, i.e., the high yield of cotton, i.e., when the yield level is 30 centners, while the yield is high, the technical costs are also high, as well as the private variables It has been shown that the large area of land increases the efficiency of agrochemical activities.

At the same time, the consumption of agrochemical fertilizers is reduced to 25 percent at the smallest level of productivity, i.e., when the productivity falls to 24 centners, but according to stochastic analysis, the degree of dependence on productivity is the highest. Also, the direct impact of the use of agrochemical techniques on productivity is high. Among the factors that indirectly affect production, we can see that the large size of the farm's land area ensures the high efficiency of agrochemical measures, and the age of the head of the farm is also noted as a factor that increases the efficiency of agrochemical measures. It should be noted that in Table 2, the values of Z4 are negative and equal to zero. Because, when analyzing the incomes of the studied farms in other sectors, if there are other incomes in the economic entities, "1" point is given, and "0" point is given if there is no income.

At the same time, the following results were obtained by calculating the degree of importance of agrochemical measures to cotton productivity, Table 3.

Table 3. Importance of factors in increasing productivity in the application of agrochemical measures

LnY	Coefficients	Standard error	Z	Interval
External and internal variables affecting the provision of agrochemical services				
LnX_1	1,02	0,2245	4,57	1,4663
LnX_2	3,26	0,0001	$3,8^{e+04}$	3,3001
LnX_3	1,45	$2,06^{e-06}$	$7,1^{e+05}$	1,0568
LnX_5	1,57	$2,31^{e-06}$	$6,8^{e+05}$	1,0729
const	-7,53	0,0001	$-4,7^{e+05}$	-6,6856
Private variables affecting the provision of agrochemical services				
LnZ_1	0,37	0,2068	1,32	0,4076
LnZ_2	0,46	$3,39^{e-06}$	$1,4^{e+05}$	0,4579

From Table 3, we can see that in the application of agrochemical measures in agriculture, labor cost (X_4) from external and internal variables, as well as private variables affecting production, work experience of the farm manager (Z_3) and income from other sectors (Z_4) due to the presence of multicollinearity from the analysis results of these factors released. Also, when evaluating the effect of agrochemical measures on productivity, if the positive effect of pesticides is the highest, the technical mechanization of agrochemical measures also has a great impact on the highest productivity.

Among the factors that indirectly affect production, the size of cultivated land of farms has a high impact on the effectiveness of agrochemical measures. According to monographic observations, the size of the cultivated area of femer farms allows to reduce the wastage of mineral fertilizers and chemical resources, and to partially reduce mechanization costs. Accordingly, we can write the stochastic model for evaluating the effect of agrochemical measures on productivity as follows:

$$lny = -7{,}53 + 1{,}02lnX_1 + 3{,}26lnX_2 + 1{,}45lnX_3 + 1{,}57lnX_5 + 0{,}37lnZ_1 + 0{,}46lnZ_2$$

The logarithmic probability of this model is g=95%, and the selected factors affect the effectiveness of agrochemical measures with a probability of 95%. The effect of factors not taken into account is equal to 5 percent.

Also, the sotastic limit is equal to s_$\sigma_u^2 = 0{,}87\ va\ \sigma_v^2 = 0{,}128$. From the analysis, we can see that the high probability of the selected factors for increasing the efficiency of agrochemical measures is equal to 87 percent, and the probability of inapplicability is 13 percent on average.

Also, the influence of agrochemical services on cotton productivity was analyzed. According to the results of the analysis, productivity as a result factor and as variable factors;

X_1 – ammonium nitrate;

X_2 – phosphorus fertilizers;

X_3 – potassium fertilizers;

X_4 – equipment consumption;
X_5 – pesticide consumption;
X_6 – labor costs were selected (Table 4).

Also, in forecasting the impact of these factors on productivity and prospective changes, the results obtained by using modern resource-efficient technologies in the selected farm were included.

Table 4. The effect of agrochemical services on the yield of cultivated cotton.

t	Y yield level c/ha	Consumption of nitrogen fertilizers is thousand soums UZS /ha X_1	Consumption of phosphorus fertilizers thousand soums UZS /ha X_2	Consumption of potassium fertilizers thousand soums UZS /ha X_3	The cost of techniques thousand soums UZS /ha X_4	Pesticide consumption thousand soums UZS /ha X_5	Labor cost thousand soums UZS /ha X_6
2013	25,7	273,7	279,2	69,3	356,0	20,6	293,3
2014	26,1	308,1	320,7	140,6	396,0	22,6	308,7
2015	25,9	373,5	379,6	140,3	495,0	28,2	385,9
2016	23,4	432,3	498,3	161,8	582,3	33,2	454,0
2017	24,0	514,2	479,7	139,5	1082,7	50,8	858,3
2018	19,8	504,5	578,6	132,7	1116,2	59,0	894,1
2019	23,7	417,4	243,1	172,4	1200,2	71,1	961,4
2020	24,9	538,3	193,6	146,7	1395,6	84,7	1131,0
2021	26,1	688,8	314,9	200,2	1734,6	101,0	1350,0
2022	37,0	618,9	489,7	224,9	2255,0	128,3	1674,0

Table 4 analyzes the productivity level of the researched farms. From 2013 to 2018, the productivity level was low due to the high production costs due to the use of traditional methods in cotton cultivation. Since 2018, due to the introduction of new agrotechnologies in cotton cultivation, production costs have decreased sharply, i.e. resource consumption has decreased by almost 45%, and there has been a significant increase in productivity.

From the data in Table 4, the pairwise correlation matrix was calculated in STATA to determine the relationship between the selected factors and the yield of cotton grown by the farmers.

Table 5. Correlation coefficient matrix of the degree of correlation between the expenditure of agrochemical activities and the income of farmers from cotton.

	Y	X_1	X_2	X_3	X_4	X_5	X_6
Y	1.0000						
X_1	0.2950	1.0000					
X_2	-0.0003	0.2162	1.0000				
X_3	0.5476	0.7575	0.1700	1.0000			
X_4	0.5472	0.8960	0.1017	0.7950	1.0000		
X_5	0.5600	0.8764	0.0148	0.8026	0.9926	1.0000	
X_6	0.5014	0.9026	0.0757	0.7769	0.9980	0.09915	1.0000

According to the results of the obtained matrix, there is no high degree of correlation between the selected factors, and we can determine that there is no multicollinearity between the selected factors, that is, the selected factors are adequate. Based on the data of Table 4, the impact of all factors on the total productivity, the level of change of the impact of agrochemical services on the productivity of raw cotton grown on farms was calculated as follows.

Table 6. Prospective changes in the impact of agrochemical measures on the yield of cultivated raw cotton

t	Y yield level c/ha	Consumption of nitrogen fertilizers is thousand soums UZS /ha X_1	Consumption of phosphorus fertilizers thousand soums UZS /ha X_2	Consumption of potassium fertilizers thousand soums UZS /ha X_3	The cost of techniques thousand soums UZS /ha X_4	Pesticide consumption thousand soums UZS /ha X_5	Labor cost thousand soums UZS /ha X_6
2023	35,2	685,0	386,3	215,3	2156,4	124,0	1664,4
2024	36,5	724,7	387,9	226,7	2355,5	135,7	1815,9
2025	37,9	764,3	389,4	238,0	2554,6	147,3	1967,4
2026	39,2	804,0	391,0	249,4	2753,7	159,0	2118,9
2027	40,2	843,6	392,6	260,8	2952,8	170,7	2270,4
2028	41,8	883,3	394,2	272,1	3151,9	182,3	2421,9
2029	43,1	922,9	395,7	283,5	3351,0	194,0	2573,4
2030	44,4	962,6	397,2	294,8	3550,1	205,6	2724,9

In conclusion From Table 6, we can see that the dependence of cotton cultivation and provision of agrochemical services on the time factor, i.e., the change in agrochemical costs and the change in the yield of cultivated cotton raw material can be seen as follows.

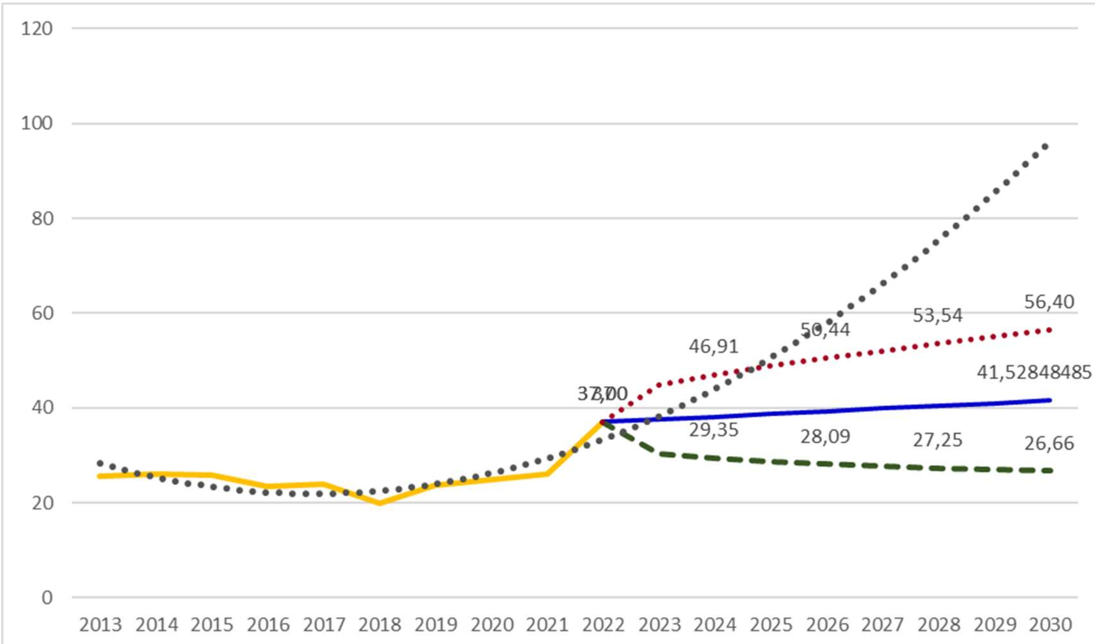

Figure 1. Changes in cotton yield in time as a result of changes in agrochemical measures

We can see from the graph that when all factors are fully taken into account, according to the logarithmic analysis, the yield is likely to be higher than the forecast indicators. However, due to factors that have not been taken into account and the sharp fluctuations in the market values of the selected resources, the yield level may increase by 56 t/h in 2030 due to the further improvement of the technologies of agrochemical measures in 2030. the productivity level is likely to be 41 ts/ha.

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