Assessment of the uncertainty factors in computer modelling of an agricultural company operation

L A Zaporozhtseva¹, T V Sabetova¹, I Yu Fedulova¹

¹ Voronezh state agrarian university, 30, Michurina Str., Voronezh, 394087, Russia

E-mail: ludan23@yandex.ru, tsabetova@mail.ru

Abstract. The design of management decisions is one of the most difficult and most creative processes in all managerial work. It requires thorough understanding of the current situation and prospects of both the company and its environment. The article considers the problem of determination of the degree of influence of uncertainty factors on the performance of an agricultural company. After carrying out a schematic factor analysis of the financial results of the agricultural company, the authors selected parameters such as crop yields and average selling price, for analyzing the degree of exposure to uncertain factors. Since both the selected parameters are affected by a large number of certain factors and factors uncontrollable for the company's management, the authors find it unacceptable to apply factor analysis to them. Instead, the suggestion is made concerning grouping all the factors on the basis of their certainty and definition of the influence degree for each group. As a result, the proposal was made for the projecting method, such as economic and mathematical modeling, to use the data from both the firm being the subject of modeling, and from the similar enterprises available from the regional Department of Agriculture. In this case, the accuracy of the forecast will be much higher, besides, it can be developed in 3 or 5 probability scenarios.

1. Introduction
The design of management decisions is one of the most difficult and most creative processes in all managerial work. Improving the efficiency of decision-making and their implementation is impossible without deep understanding of the current situation in the external and internal environment of an organization, as well as knowledge of the characteristics of those who make and execute these decisions [1]. The peculiarity that in modern companies management decisions are often made by one group of employees (specialists), approved by the other (managers) and executed by yet another one (workers and executives), further complicates the procedure and its quality at all stages. In modern management, the theory of procedural rationality is recognized and widely used, the technological and procedural foundations of which contribute to making sound and efficient decisions. On the other hand, non-observance of the theory of procedural rationality can create a number of difficulties, including drastic decline in the economic efficiency and competitiveness of business units and their strategic areas of management, and as a result - development slowdown at the company, regional, and national levels [2]. Hence, a deep study of methods and procedures for management decision-making within companies and organizations is important both from a theoretical and purely practical points of view for developing methodological guidelines for ensuring the effectiveness of management decision-making and ensuring the controllability of their execution from quantitative and qualitative positions.

Under the actual business conditions, achievement of the same objective is possible in several ways,
differing not only in terms of specific actions, but also in efficiency, interpreted as the ratio of result and cost (effort and resources invested). Thus, some of them seem more attractive, while others less so. The existence of a variety of options for action to achieve the objective is associated with the influence of a variety of diverse and often complexly interrelated conditions and factors in production, commercial, and financial activity [3].

In the agricultural sector of the economy, a systematic approach is needed based on the use of mathematical modelling methods and modern PCs to effectively solve production problems and achieve the goals of rational use of natural, human, financial and other resources [4, 5]. The correct performance of the model and its usefulness for practical activities, however, is possible only with its proper construction, which requires the application of corrections in it to the influence of factors of uncertainty and risk affecting the operation of the simulated object.

The development of any economic system takes place under the influence of risk factors and uncertainties, the inclusion of which is crucial in the development and justification of management decisions, especially those long-term and of strategic importance. On the other hand, many of the operating parameters of such systems are simultaneously affected by a number of factors, some of which are definite and stable, or have stable trends of changes, which makes their prediction highly accurate. The other part of the factors is completely or substantially controlled by the actions of the system itself, for example, the management of a company or administration of a municipality, and such an impact may be planned quite effectively. Some of the factors cannot be described as either stable or even predictable. A full-scale factor analysis for each indicator of the socio-economic system is often difficult, but definition of the degree of controllability of the indicator remains an important task for its strategic management. The study performed was aimed at improving the methods of such detection.

2. Problem statement

We undertook the analysis of risks and uncertainty in the operation of agricultural companies of Verkhnaya Hava district of Voronezh region, in general, and particularly MTS Agroservice, LLC. Its results demonstrated that among the most susceptible to uncertainty of the performance indicators are the crop yield (as the company is completely crop-growing, without animal husbandry) and the sales price of products. The scheme of the impact of these indicators on the resulting financial and economic indices of the company are shown in Figure 1 [6, 7].

![Figure 1](image-url). Scheme of uncertainty impact on profit and profitability indicators.

The performed factor analysis visually represents the zones of occurrence of the influence of indicators, partially or completely being uncertain, on the results of the company’s activity.
The data available for us, as well as for the most third-party researchers for the company, do not allow a deep study of all the factors and parameters of the purchase prices of the raw materials obtained by the company to support its activities, as well as the fixed assets. However, the degree of controllability of the other two parameters in the scheme of factor analysis, we can consider and evaluate quantitatively.

The agricultural company, used as an example, sells a relatively wide range of crops. The sales revenue structure received due to crop production for 2017 is visualized in Figure 2.

![Figure 2. Structure of revenue from sales of crop products of MTS Agroservice LLC for 2017.](image)

It can be noted that the shares of sugar beet, wheat and sunflower in 2017 were significantly higher than the shares of other crops. We propose to consider the impact of yields and sales prices on performance and management decisions on the example of two crops with the maximum share in the revenue structure: wheat and sugar beet.

First of all, we considered the factors affecting crop yields. Without listing all of them and not assessing the degree of influence of each of them, we consider it more correct to divide them simply by two indicators: on the one hand, stable or changeable, and on the other hand, controlled or not controlled by the company management. The results of this division are presented in Table 1.

| Company’s control | Yes | No |
|-------------------|-----|----|
| Weather conditions of a certain period | Diseases and pests | Soil fertility (partial control by means of fertilizers and other methods) |
| Natural and industrial disasters and other emergencies | | Agro-engineering methods |
| Physical-geographical conditions (such as relief, daylight duration) | | Variety and species characteristics (though the crops and varieties are selected by the company) |
| Economic-geographical conditions (distance to the consumers and suppliers, transport infrastructure) | | |

We can state that a highly significant part of the factors taken for example is beyond the control of the company, and the only thing the management can do to achieve the best results is their adequate taking into account when making decisions. Naturally, when planning company’s activities, it is much easier to take into account the factors that remain unchanged over long intervals, but at the same time it is necessary to take into account the conditions that may vary considerably in each production cycle and even in different segments of it.

Parameters controlled by a company can compensate, to a certain extent, for the influence of...
uncontrollable factors, since all the listed conditions affect the result in combination.

3. Assessment of uncertainty factors on the crop yields

Sound management decision making is difficult without deep understanding of the influence degree of each of the affecting factors, including uncertain ones, upon the final result [8]. However, individual consideration of the factors shown in Table 1 is problematic for two reasons. First of all, it is not possible for all of them to collect correct quantitative information both in our study and in general. Secondly, it will be necessary to determine the weight values for the factor analysis of crop yield, that is, to resort at least to expert estimates, the accuracy of which can also raise questions. However, we proposed a relatively simple way of determining the degree of influence of factors within the two groups: controlled by the company, not controlled by its management and changing from one production cycle to the other (in this case, the year, as the crop production is analyzed). To do this, we reviewed and compared the yield dynamics of selected crops for the survey period, both in the company under consideration and in neighboring ones, which operate in virtually similar external conditions.

Such comparison of wheat yield dynamics is shown in Table 2.

| Company                          | Years 2013 | Years 2014 | Years 2015 | Years 2016 | Years 2017 | 5-year average | Standard deviation |
|----------------------------------|------------|------------|------------|------------|------------|----------------|-------------------|
| MTS Agroservice LLC              | 45.3       | 53.1       | 46.3       | 40.8       | 60.2       | 49.1           | 6.8               |
| Zolotaya Niva LLC                | 27.1       | 29.5       | 26.9       | 35.7       | 41.5       | 32.1           | 5.7               |
| Luch LLC                         | 37.7       | 32.8       | 35.2       | 33.1       | 36.7       | 35.1           | 1.9               |
| Saturn LLC                       | 40.0       | 36.6       | 28.0       | 31.5       | 38.0       | 34.8           | 4.4               |
| Kostin &K LLC                    | 45.0       | 27.2       | 28.6       | -          | -          | 33.6           | 8.1               |
| Lugovatskoye LLC                 | 40.0       | 40.5       | 33.5       | 33.0       | 42.1       | 37.8           | 3.8               |
| Ovosch-Prod-Holding LLC           | 57.1       | 48.4       | 24.5       | 48.4       | 59.8       | 47.6           | 12.4              |
| District average                 | 41.7       | 38.3       | 31.9       | 37.1       | 46.4       | 38.6           | 4.9               |
| Standard deviation               | 8.4        | 8.9        | 14.9       | 8.8        | 9.8        | 6.4            | -                 |

There are several indicators that allow us to assess the variation degree of the values in each row; we have chosen one of the simplest ones - the standard deviation. The observed variation of fluctuations by year within the same company (column “Standard deviation”) turned out to be significantly smaller than the variation among companies of the region in the same year (line “Standard deviation”). The standard deviation for average annual yields in different farms was 6.4, while the average for the surveyed company for different years was only 4.9. These calculations allowed us to conclude that the effect of the measures taken by the company to ensure the desired or planned yield level does not give produce guarantees of the result, but it is determined to a very large extent, mitigating the distorting effect of uncontrollable factors. In this case, it can be argued that the study of the dynamic series of fluctuations in the yield of winter wheat confirms this consideration.

We also used a similar technique to assess the influence of two groups of factors on the yield of sugar beet (Table 3). In the Verkhnaya Hava district, only two companies grow sugar beets, which is not enough for statistical observation [9]. So, we had to compare this indicator with the nearest and similar in terms of geographic conditions districts: Panino, New Usman, and Ertil. In the first one no company grows sugar beets, in New Usman district only one company represents this sector, and we selected 3 largest sugar beet producers in Ertil district.
Table 3. Dynamics of sugar beet yield in the farms of Verkhnaya Hava and adjacent districts of Voronezh region, c/ha.

| Company              | 2013  | 2014  | 2015  | 2016  | 2017  | 5-year average | Standard deviation |
|----------------------|-------|-------|-------|-------|-------|----------------|-------------------|
| MTS Agroservice LLC  | –     | 359.1 | 487.1 | 551.5 | 562.2 | 490.0          | 80.8              |
| Luch LLC             | 455.4 | 416.6 | 359.1 | 454.2 | 480.9 | 433.2          | 42.4              |
| Logus-agro LLC       | 664.8 | 393.4 | 396.0 | 658.7 | 671.8 | 556.9          | 132.5             |
| Agrotech-Garant      | 524.2 | 461.7 | 552.6 | 606.1 | 603.9 | 549.7          | 53.9              |
| Rostoshinskiy LLC    | 479.4 | 421.2 | 494.8 | 471.6 | 421.1 | 463.7          | 25.6              |
| Agrocultura Ertel LLC| 357.7 | 251.3 | 339.5 | 471.6 | 368.2 | 368.2          | 75.0              |
| Average among companies | 496.3 | 392.5 | 438.2 | 527.2 | 531.7 | 477.0          | 53.9              |
| Standard deviation   | 100.3 | 74.0  | 78.0  | 85.4  | 88.7  | 65.5           | –                 |

The data in Table 3 confirm the pattern revealed by the example of wheat, although it is not so obvious: the differences in the sugar beet yields among the companies remain more significant than among the years.

Such calculations confirm our conclusion about the significant impact of agro-technical and other measures undertaken by the company on crop yields. Outside the scope of this article, we carried out similar calculations for two more cultures, and to a certain extent, a similar pattern was observed everywhere. Hence, we can argue the importance of revitalizing the activities of any agricultural company in order to ensure the planned level of crop yields. At the same time, such measures also act as a risk management tool, where the damage is the shortfall in yields.

4. Assessment of uncertainty factors on the sales price

Similar methodology is applicable in principle to any resultant indicator, if it depends on these two factors: controlled by the company and risk factors and uncertainties. We used it to determine the degree of control of a company over the sales price of goods as another indicator, partially controlled and partially uncertain. This value is generally described by significant volatility, and depends on a huge number of factors. There are quite a few among them that can be considered stable over long periods of time. There are not so many among them that can be considered stable over long periods of time [10, 11]. Therefore, we did not find it possible to build a matrix with four cells for factor analysis, similar to table 1. On the contrary, we directly divided all the factors affecting it into two groups: those controlled by the company (although most often there is partial control) and those outside its influence.

The following parameters can be attributed to the first group: the assortment of products, and the range of manufactured and marketable products should be divided in agriculture; the quality parameters; sales volumes; sales channels used; selection of specific organizations-buyers; selection of delivery time, taking into account the seasonality of production; production cost and selling expenses.

In the second group, we included such factors as: macro- and meso-economic situation; market forecasts; consumer expectations; government intervention in the sectoral market; geographically accessible market segment and its characteristics.

In this case, we again set ourselves the task of estimating not so much the influence of each individual factor from the whole mass, but each of the two selected groups.

To achieve this objective, we analyzed the price dynamics for the same product types and the same companies that were surveyed when assessing the dynamics of yield. Table 4 presents the wheat price dynamics in Verkhaya Hava district.
Table 4. Dynamics of the price of wheat in the farms of Verkhnaya Hava and adjacent districts of Voronezh region, RUR per c.

| Company                  | 2013  | 2014  | 2015  | 2016  | 2017  | 5-year average | Standard deviation |
|--------------------------|-------|-------|-------|-------|-------|---------------|--------------------|
| MTS Agroservice LLC      | 510.1 | 568.6 | 820.1 | 1031.8| 604.8 | 707.1         | 193.2              |
| Zolotaya Niva LLC        | 547.4 | 480.1 | 741.1 | 839.2 | 617.3 | 645.0         | 129.9              |
| Luch LLC                 | 642.8 | 802.9 | 896.1 | 821.9 | 631.0 | 758.9         | 104.5              |
| Saturn LLC               | 544.5 | 554.7 | 695.9 | 933.5 | 685.6 | 682.8        | 140.4              |
| Kostin &K LLC           | 544.6 | 569.4 | 548.6 | 591.1 | 563.4 | 18.5          | -                  |
| Lugovatskoye LLC         | 600.0 | 647.0 | 847.1 | 813.7 | 543.2 | 695.6         | 118.1              |
| Ovosch-Prod-Holding LLC  | 516.3 | 591.2 | 800.7 | 715.3 | 662.8 | 99.1          | -                  |
| District average         | 558.0 | 605.8 | 800.2 | 814.9 | 623.3 | 673.7        | 106.1              |

Table 5. Dynamics of the price of sugar beet in the farms of Verkhnaya Hava and adjacent districts of Voronezh region, RUR per c.

| Company                  | 2013  | 2014  | 2015  | 2016  | 2017  | 5-year average | Standard deviation |
|--------------------------|-------|-------|-------|-------|-------|---------------|--------------------|
| MTS Agroservice LLC      | –     | 179.7 | 297.3 | 253.6 | 160.2 | 222.7         | 55.4               |
| Luch LLC                 | 161.6 | 159.2 | 177.9 | 191.1 | 151.9 | 168.3         | 14.2               |
| Logus-agro LLC           | 163.5 | 182.4 | 283.7 | 251.0 | 212.7 | 218.7         | 44.0               |
| Agrotech-Garant          | 138.4 | 204.2 | 312.2 | 293.9 | 268.0 | 243.3         | 64.0               |
| Rostoshinskii LLC        | 149.9 | 192.1 | 299.7 | 259.9 | 230.5 | 226.4         | 52.0               |
| Agrocultura Eritil LLC   | 150.2 | 228.8 | 311.3 | 279.4 | 235.7 | 241.1         | 54.5               |
| SHP Viktoria LLC         | 152.7 | 191.1 | 280.4 | 254.8 | 209.8 | 217.8         | 45.4               |
| Average among companies  | 152.7 | 191.1 | 280.4 | 254.8 | 209.8 | 217.8         | 45.4               |
| Standard deviation       | 9.1   | 21.7  | 46.8  | 32.2  | 41.4  | 24.9          | –                  |

As we expected based on the number and significance of uncertainty factors affecting the price, the data in Table 4 indicate a much more significant variability in the wheat sales price by year than by company within one year. This suggests that the influence of external factors uncontrolled by the company on the price is much stronger and not easily mitigated by the actions of the company's management.

Again, the application of the technique was repeated for sugar beet (Table 5) and two other cultures. Average prices are calculated for the sample under study, and not as a whole in three districts.

Table 5. Dynamics of the price of sugar beet in the farms of Verkhnaya Hava and adjacent districts of Voronezh region, RUR per c.

For sugar beets as well as two other crops, we detected similar situation as for wheat prices. The influence of uncontrollable risk factors and uncertainties is significantly stronger than the efforts of companies to minimize and mitigate them.

Based on the above-mentioned we can draw the following conclusions:

1. All the performance indicators of an agricultural company, including parameters of economic efficiency and financial sustainability, are more or less affected by risk factors, that is, those that change over time and are not controlled by the company’s management.
2. We studied in detail the two indicators that are partially affected by such factors, which are crop yields and the sales prices. The examples of four crops, including two, which form the basis of the surveyed company's revenue, showed that controlled factors have more influence upon the yield, while the impact of risk factors has stronger effect on the sales price.
3. That is why we consider ourselves entitled to assert that when planning production and making management decisions, it is important to exert maximum efforts with the purpose of increasing or stabilization of the yield at the desired level and mitigate the influence of uncontrollable factors on it.
4. As for the sales policy of the company, management efforts here have much smaller effect. Therefore, instead of marketing efforts, in particular, on finding the most effective sales
channels, assortment planning, product promotion, it is sufficient to take into account the possible limits of price volatility when planning and form reserves for its compensation.

The application of these recommendations in the planning of production and marketing of agricultural products can be promoted by the active use of economic and mathematical modeling of processes in the company, and the models must take into account the factor of price volatility in the sales of products and be developed in at least three scenarios.

5. Design of the variants for economic mathematical modelling of companies’ development under the uncertainty conditions

The agricultural companies of the Voronezh region have access to the information about other farms from the regional Department of Agricultural policy and from various information sites concerning the state and dynamics of agricultural development in the region. Consequently, they can select and analyze the performance of other companies that produce a similar product range in similar natural and socio-economic conditions. This gives us the reason to propose designing the models using the data of both the company in question (the object of modelling), and information on other companies of the district and region.

We propose the following sets of modeling variants:

1. Based on the application of the own data of the company in question only: (i) the optimistic: the best performance indicators of the company in the last 5–7 years; (ii) the pessimistic: the worst performance indicators of the company in the last 5–7 years; and (iii) the most probable: weighted average indicators of the company for the last 5–7 years.

2. Based on the application of both the data of the company and the district where it is located: (i) the optimistic: the best performance indicators among the companies of the district; (ii) the pessimistic: the worst performance indicators among the companies of the district; and (iii) the most probable: weighted average indicators of the companies of the district for the last 5–7 years.

3. Moreover, we recommend expanding this option to 5 scenarios: optimistic for district, optimistic for company (what is named above as “optimistic”), most probable, pessimistic for company (named above as “pessimistic”), pessimistic for district. In this case, determination of the most likely scenario can be performed using the weighted average of the area or the average between the company and the area as a whole.

4. Based on the dynamic expectations: (i) the optimistic: the best performance indicators of the company in the last 5–7 years corrected for the effort applied for their improvement (usually +5–7 %, but no better than the best district indicators); (ii) the pessimistic: the worst performance indicators of the company in the last 5–7 years corrected for the effort applied for their improvement (usually +5–7 %, but no worse than the district average indicators in the worst year in terms of the indicator in question); and (iii) the most probable: weighted average indicators of the company for the last 5–7 years corrected for the effort applied for their improvement (usually +5–7 %, but no worse than the district average indicators for the whole period).

Management decisions taking into account the natural and economic conditions and market conditions, in which MTS Agroservice, LLC, and other similar companies operate, require grounding according to the scheme presented in Figure 3.
6. Conclusion

Grounding of the decisions concerning the production activities should be carried out mainly on the basis of internal capabilities, wishes, as well as technological, scientific, and technical requirements.

In the area of commercial activity, a company virtually cannot affect most of the processes, and therefore the only way it can be protected from the influence of uncertainty and risks is taking them into consideration. For this purpose, authoritative and reasonable forecasts should be used, and plans and decisions should provide for several options for the development of market conditions and the company's actions to respond to them.

In the financial area, decisions should take into account the need of creating reserves to compensate for the negative impact of external uncontrolled factors.

References

[1] Zaporozhtseva L A and Sabetova T V 2016 Sustainable development strategy formation for business corporations Proceedings of VSUET 2 350–355
[2] Shevtsova N M and Feduliva I Yu 2016 Competitiveness of the regions of the Central Black-soil area of the Russian Federation Economy and entrepreneurship 2–1(67–1) 265–268.
[3] Le Cotty T, D’Hotel E M and Soubeiran R 2018 Linking Risk Aversion: Time Preference and Fertiliser Use in Burkina Faso Journal Of Development Studies 54(11) 1991-2006
[4] Kulev S A 2014 Informatics and programming: study guide (Voronezh VSAU)
[5] Kuehne G, Llewellyn R and Pannell D J 2017 Predicting farmer uptake of new agricultural practices: A tool for research, extension and policy Agricultural Systems 156 (Sept) 115-125
[6] Zhurkina T A, Mezheritskaya N N and Izmaylova L N 2015 Accounting and analysis of cost in crop farming Economy and entrepreneurship 10–2 (63–2) 789–791
[7] Zhurkina T A, Izmaylova L N and Mezheritskaya N N 2017 Analysis Of Risks Associated With The Use Of Fixed Assets Russian Journal of Agricultural and Socio-Economic Sciences 64(4) 63–67
[8] Panina E B, Panin A I and Meshkova I N 2015 Assessment of the influence of the company’s macro-environmental factors using PEST-analysis method *Theory and practice of the third millennium: ed. A A Sukiasyan* (Ufa AETERNA) 36–39

[9] Fedulova I Yu 2016 Strategic goals and directions of governmental support of Russian agro-industrial complex *Economy and entrepreneurship* 5(70) 957–961

[10] Charykova O G and Chernyshova I I 2016 The model of the prospective grain market development based on marketing principles *FES: Finance. Economy. Strategy* 4 40–44

[11] Zagvozkin M V and Sabetova T V 2016 Consideration Of The Price Fluctuations In Companies' Planning And Public Control Of The Agricultural Product Market *Russian Journal of Agricultural and Socio-Economic Sciences* 57(9) 58–66