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THE EVOLUTION OF APPLICATION MATHEMATICAL STATISTICS METHODS HAVE PRESENTED FOR PROCESSING OF RESULTS OF FIELD EXPERIMENTS IN AGRICULTURE IN UKRAINE (SECOND HALF OF XIX – BEGINNING OF XXI CENTURIES)

The evolution of application mathematical statistics methods have presented for processing of results of field experiments have provided the accuracy and reliability of the received results of research, detection of earlier unknown regularities for the favourable growth and development of crops. It's determined that for implementation of scientific studies in agriculture application of analysis of variance of statistical data in multivariate experiences is effective that has allowed establishing the hidden dependencies of many biological phenomena. The dynamics of interrelation of the basic factors of agriculture have estimated: application of crop rotations, tillage, fertilization, means of plants protection and weather conditions on cropping capacity in Ukraine during the second half of the XIX – at the beginning of the XXI centuries.

Key words: *evolution, methods of mathematical statistics, analysis of variance, agriculture, land-tenure, crops.*

Obtaining high and stable yields of crops is possible only when you create the plants of favourable conditions for growth and development. It provides at an optimal level all processes of energy conversion and metabolism in a plant body, beginning from photosynthesis and finishing with formation of the end products of plants' life-sustaining activity: proteins, fats, carbohydrates, vitamins, minerals, etc. A necessary condition of obtaining high and stable yields of crops with the best quality data is

providing continuous process of organic matter formation, avoiding even momentary interruptions in work both photosynthesis in general, and separately each plant.

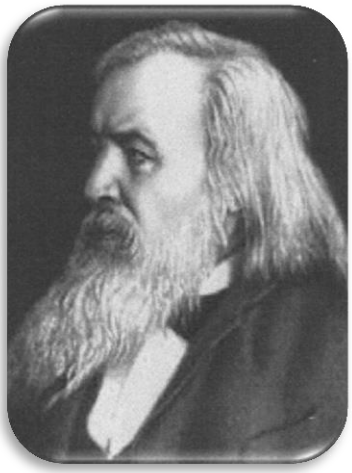
For this purpose, at all stages of modern scientific researches in agriculture provides widespread use of mathematical statistics, which allows establishing absconded dependencies which are inherent in many biological phenomena. Using mathematical statistics in agriculture provides the accuracy and ambiguity, degree of reliability and reliability of conclusions; promotes to a deeper assessment of the essence of research and industrial problems; revealing before unknown regularities and setting new real tasks to solve in the future.

Aristotle

Using mathematical statistics for processing of results of field experiments led to the emergence and development of proper right methods, which became in future an integral part of experimental research in agriculture. Their improvement is one of the main ways of increasing the efficiency, productivity and quality of scientific researches in agriculture.

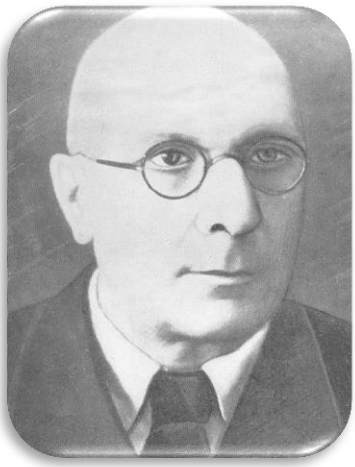
R. E. Fisher

First information about the correlation principles, as compliances and interrelations of various factors, is brought in labours of the prominent Ancient Greek philosopher-thinker, scientist-encyclopaedist Aristotle [1, p. 306]. Although more systemically in scientific researches began using it in 1783 due to a curve of random variables' distribution of the French scientist P. Laplace and the least square method of the German scientist K. Gauss. In 1889 English statisticians F. Galton and K. Pearson have developed a technique of the correlation and regression analysis. But the particular contribution in the development of design statistics methods of experiment was made



D. I. Mendeleev

by the English scientist R. E. Fischer who in 1935 has developed design mathematical methods of experiment [2], in 1938 – the theory of statistical test of hypotheses, such as analysis of variance [3]. A scientist has for the first time proved expediency of a simultaneous variation by all factors as opposed to widespread one-factorial experiment. He has developed the basis of analysis of variance, having described it full classification.



M. F. Derevitsky

In the second half of XIX – at the beginning of the XX centuries methods of mathematical statistics for processing of results of researches in agriculture have gained broad-scale development in scientific space. In the Russian Empire statistical methods processing of results of researches in agriculture for the first time in 1867 have applied by D. I. Mendeleev, have improved in 1929 – M. F. Derevitsky [4–5], in 1931 – V. M. Peregudov [6–7]. Domestic scientists focused their attention on the necessity for their application to solve the accuracy of field experiments in agriculture: O. G. Doyarenko [8], M. A. Egorov [9–10]. They developed a method of analyzing research data with obligatory using methods of mathematical statistics.

O. G. Doyarenko

In 1911 the outstanding agricultural scientist M. M. Wolf was one of the first domestic scientists who applied mathematical methods (Theory of Probability and Mathematical Statistics) to the observational analysis in agriculture. In the special section «Mathematical Signs of a Number of the Results Predetermined by Overwhelming Influence of Constant Factors» in labour «Works of a network of collective experiences with mineral fertilizers in the Ekaterinoslavska province» the scientist argued with application of the mathematical analysis have

M. A. Egorov

received by more exact expressions of sizes which characterizing the received series [11, pp. 110–114]. He proposed to use for the analysis of statistical series the table of deviations' distribution of K. Gauss. The specified labour scientists in the field of agriculture especially the processing and statements of equipment of the grain yields accounting in average sizes.

M. M. Wolf

M. M. Wolf the first in scientific practice has applied mathematical methods to an assessment of the received results of field experiments at the Kharkiv experimental station.

In the first half of the XX century when performing methodological researches O. K. Filipovskyy made the first attempts to analyze the implementation of mathematical methods in terms of accuracy of the obtained results in the textbook «Agricultural research work» [12], M. M. Tulaykov in the reference book «Materials on the Equipment of Field and Laboratory Trials» [13] and A. O. Sapegin in a practical grant for researchers «Variation statistics» [14]. They have reflected scientific bases of agriculture; have shown that there were already certain directions of practical application of Theory of Probability and Mathematical Statistics. They have developed the corresponding techniques of the input-output analysis and an assessment of accuracy of field multivariate experiments for the problems solution in agriculture.

M. M. Tulaykov

A. O. Sapegin

Achievements on the practical use of the Theory of Probability and Mathematical Statistics methods promoted the further improvement of field experiment planning and statistical processing of experimental results. Examples of such researches are labours of scientists P. N. Konstantinov [15–17] and

O. S. Molostov [18–19] about methods of an assessment on data and measures of increase the accuracy of field experiments.

P. N. Konstantinov

In the second half of the XX century the system approach to researches in agriculture with statistical analysis of test result has found the best synthesizing embodiment in B. O. Dospekhov's labours [20–21]. At the beginning of the XXI century dependencies between specific series of experience (an atmospheric precipitation, temperature and moisture of air, precursors, saturation of rotations crops with arable crops, resistance to diseases and predators, crop capacity, efficiency of crop rotations, quality of products) find by means of methods of mathematical statistics – correlation indexes for linear dependencies and correlation relation for curvilinear relationships [22–25].

B. O. Dospekhov

On the ground of long-term researches the efficiency of crops cultivation in stationery multivariate field experiments by the author interconnections between rational land-tenure and major factors of agriculture and weather conditions are defined and mathematically evaluated. Analysis of variance is a method of the analysis of statistical data in multivariate experiences have applied to set up the proportion of interconnections [19, p. 162; 20, p. 337]. It's based on defining activities as systematic (controlled) and random (uncontrollable) factors and their interconnections on variation of the results rating of the common features [5, pp. 479–492; 7, pp. 5–11; 21, pp. 285–289].

It is mathematically estimated a share of interconnection of major factors of agriculture: application of crop rotations, tillage, fertilization, plant-protecting agents, other factors (application of grades and hybrids, seed preparation, seeding rate and depth, the sowing periods) and weather conditions on ability of grain crops in Ukraine during the second half of XIX – at the beginning of the XIX centuries (fig. 1.).

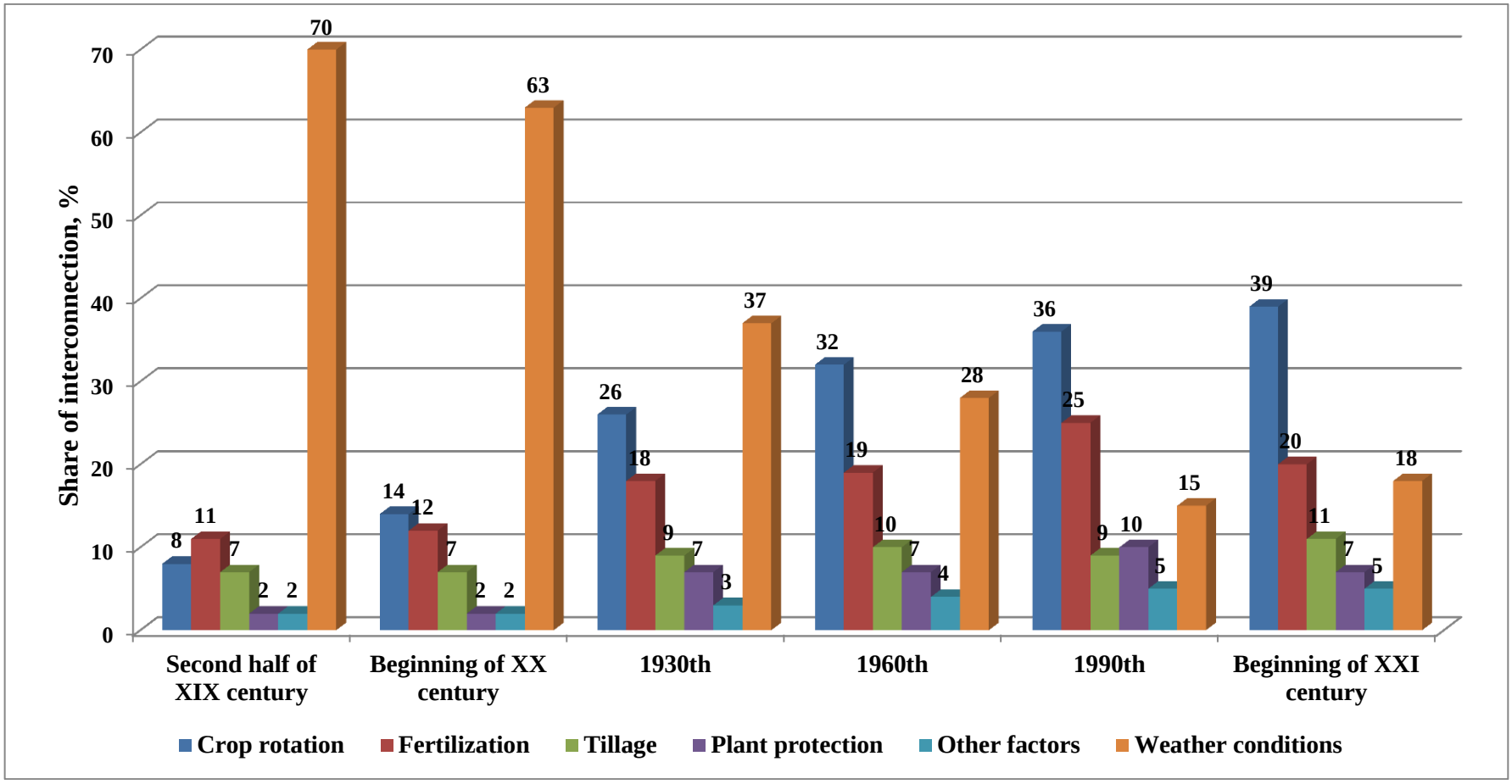


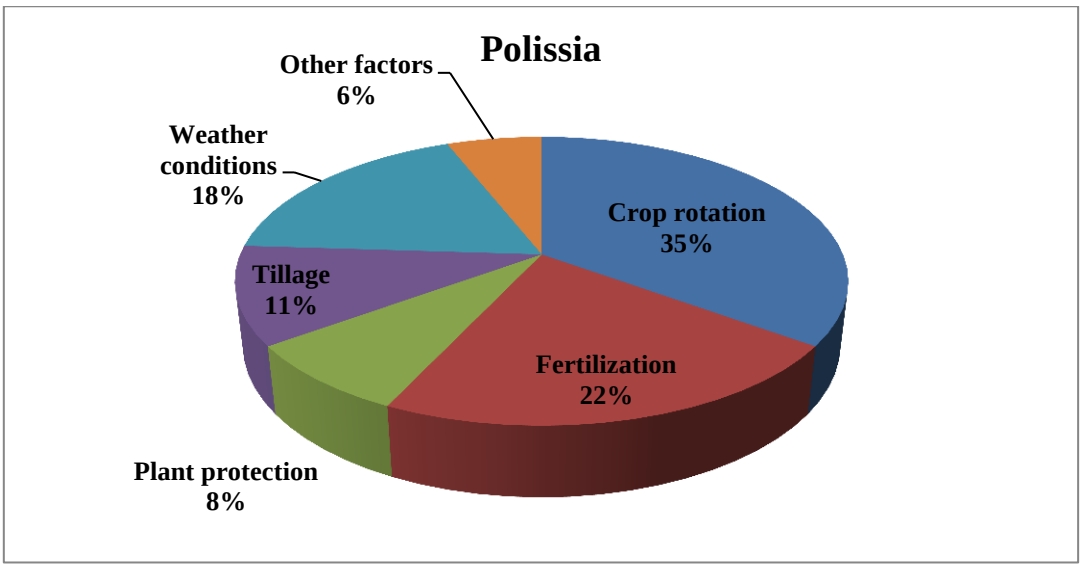
Fig. 1. Dynamics of a share of interconnection of agriculture major factors of agriculture and weather conditions on capability of grain crops in Ukraine during the second half of XIX – at the beginning of the XXI centuries, %

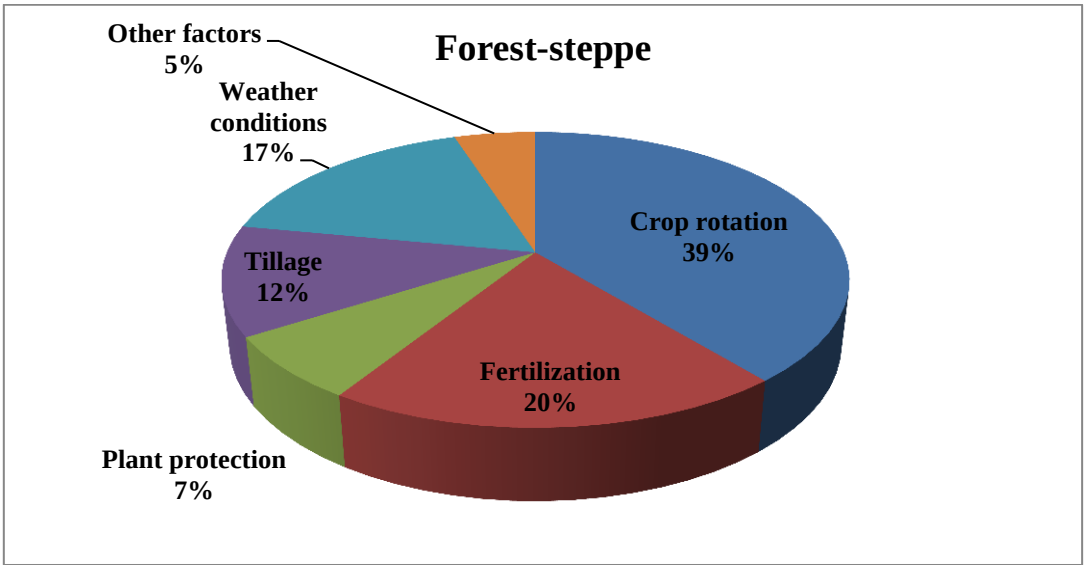
Dynamics as a result of processing by method of the analysis of variance of long-term data on agricultural crop capacity indicates an increase in years a share of interconnection on ability of grain crops of all agricultural factors which provided reduction of negative impact of adverse weather conditions from 70 % to 18 %. In particular, the share of a crop rotation factor more than for one and a half centuries has grown by 31 %, fertilization – by 9 %, plant protection – by 5 %, tillage – by 4 %. This confirms the relevance of the usage of scientifically based agrophytocenoses which improved for years.

It is mathematically estimated a share of interconnection of major factors of agriculture: application of crop rotations, tillage, fertilization, plant-protecting agents, other factors (application of grades and hybrids, seed preparation, seeding rate and depth, the sowing periods) and weather conditions on rational land-tenure in Ukraine at the beginning of the XXI. Every factor at various aberrations (in extreme cases) can become decisive and limit the size of a possible harvest for certain edaphoclimatic conditions.

As a result of cultivation by analysis-of-variance method of long-term data on agricultural crop capacity in Polissia, Forest-steppe zone and Steppe of Ukraine it has determined that the greatest share of interconnection on rational land-tenure makes the crop rotation factor (fig. 2). The following factors could be placed in the descending row: fertilization – 18–22 %, weather conditions – 17–20 %, tillage – 10–12 %, plant protection – 6–8 %, other reasons (grades and hybrids, seed preparation, seeding rate and depth, the sowing periods) – 4–6 %.

It has established a share of interconnection of major factors of agriculture (crop rotation, fertilization, tillage) and weather conditions on the yield of the leading crops in the Forest-steppe zone of Ukraine. The largest share of interconnection on yield of winter wheat, barley, corn, peas, sugar beet crop rotation makes a crop rotation factor – 41,3–54,2 % (fig. 3). The following factors could be placed in the descending row: weather conditions – 18,7–25,3 %, fertilization – 16,1–23,5 %, tillage – 10,1–16,5 %.





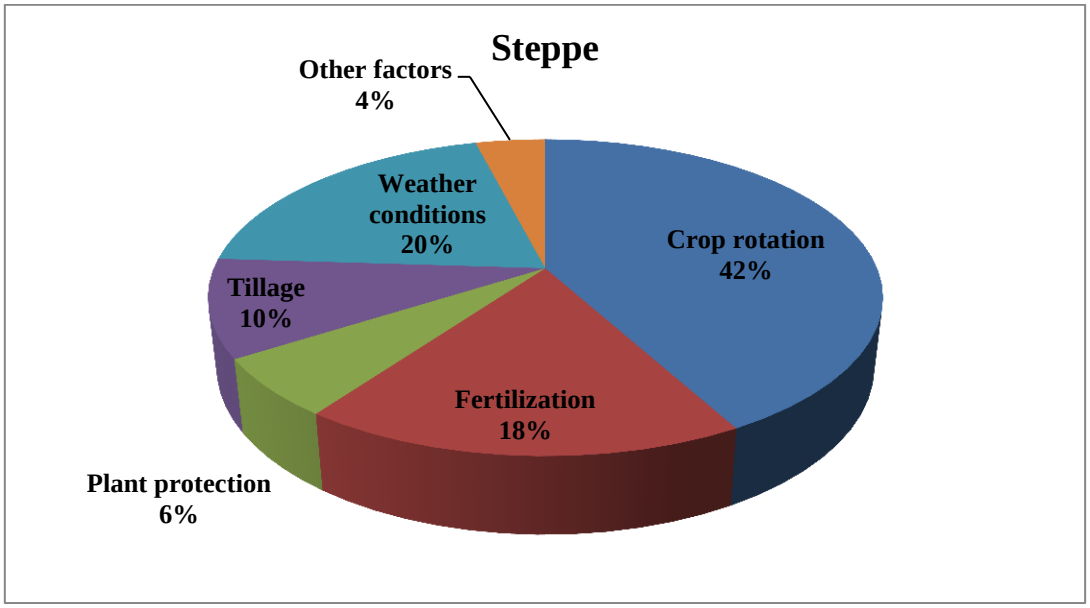


Fig. 2. A share of interconnection of major factors of agriculture and weather conditions on rational land-tenure in Ukraine at the beginning of the XXI century, %

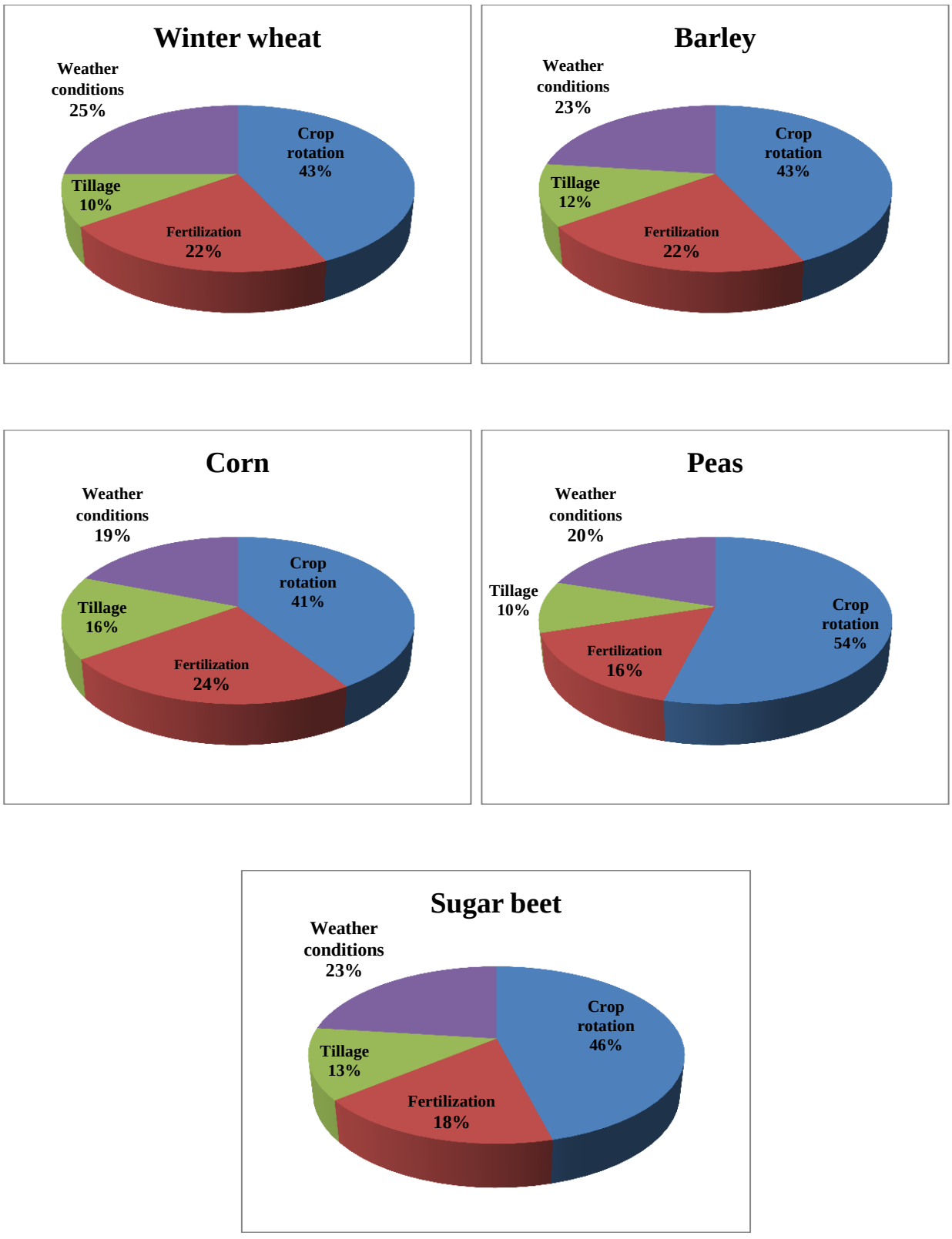


Fig. 3. A share of interconnection of major factors of agriculture and weather conditions on the yield of the leading crops in the Forest-steppe zone of Ukraine at the beginning of XXI century, %

It has defined a share of joint interconnection of a crop rotation and other factors of agriculture (fertilization, tillage, plant protection) on the yield of the leading crops in the Forest-steppe zone of Ukraine (fig. 4.). The greatest share of interconnection on the yield of all crops observes at interaction of a crop rotation factor with fertilization, which makes 6,7–8,3 %; the smallest – at interaction of a crop rotation factor with plant protection – 2,8–3,3 %; the mediocre place has taken by interaction of a crop rotation factor with tillage – 4,0–4,6 %.

For winter wheat percent from joint interconnection of a crop rotation and fertilization a share of crop rotation factor makes 56,4 %, fertilization – 35,3 %, interconnection of these factors – 8,3 %; percent from joint action of a crop rotation and tillage a share of a crop rotation factor makes 75,6 %, tillage – 19,8 %, interconnection of these factors – 4,6 %; percent from joint action of a crop rotation and plant protection f share of a crop rotation factor makes 86,5 %, plant protection – 10,4 %, interconnection of these factors – 3,1 %.

For barley percent from joint interconnection of a crop rotation and fertilization a share of a crop rotation factor makes 55,2 %, fertilization – 36,7 %, interconnection of these factors – 8,1 %; percent from joint action of a crop rotation and tillage a share of a crop rotation factor makes 72,3 %, tillage – 23,5 %, interconnection of these factors – 4,2 %; percent from joint action of a crop rotation and plant protection a share of a crop rotation factor makes 85,7 %, plant protection – 11,0 %, interconnection of these factors – 3,3 %.

In such a way, the emergence of mathematical statistics methods has happened in Ancient Greece to the first mention of correlation principles in the labours of the outstanding philosopher-thinker, scientist-encyclopaedist Aristotle. At the beginning of the XX century statistical methods for processing of researches' results in agriculture had developed in the labours of domestic scientists. Application of mathematical statistics methods for processing of results of field experiments has provided the accuracy and reliability of the received results of research, detection of earlier unknown regularities for the favourable growth and development of crops.

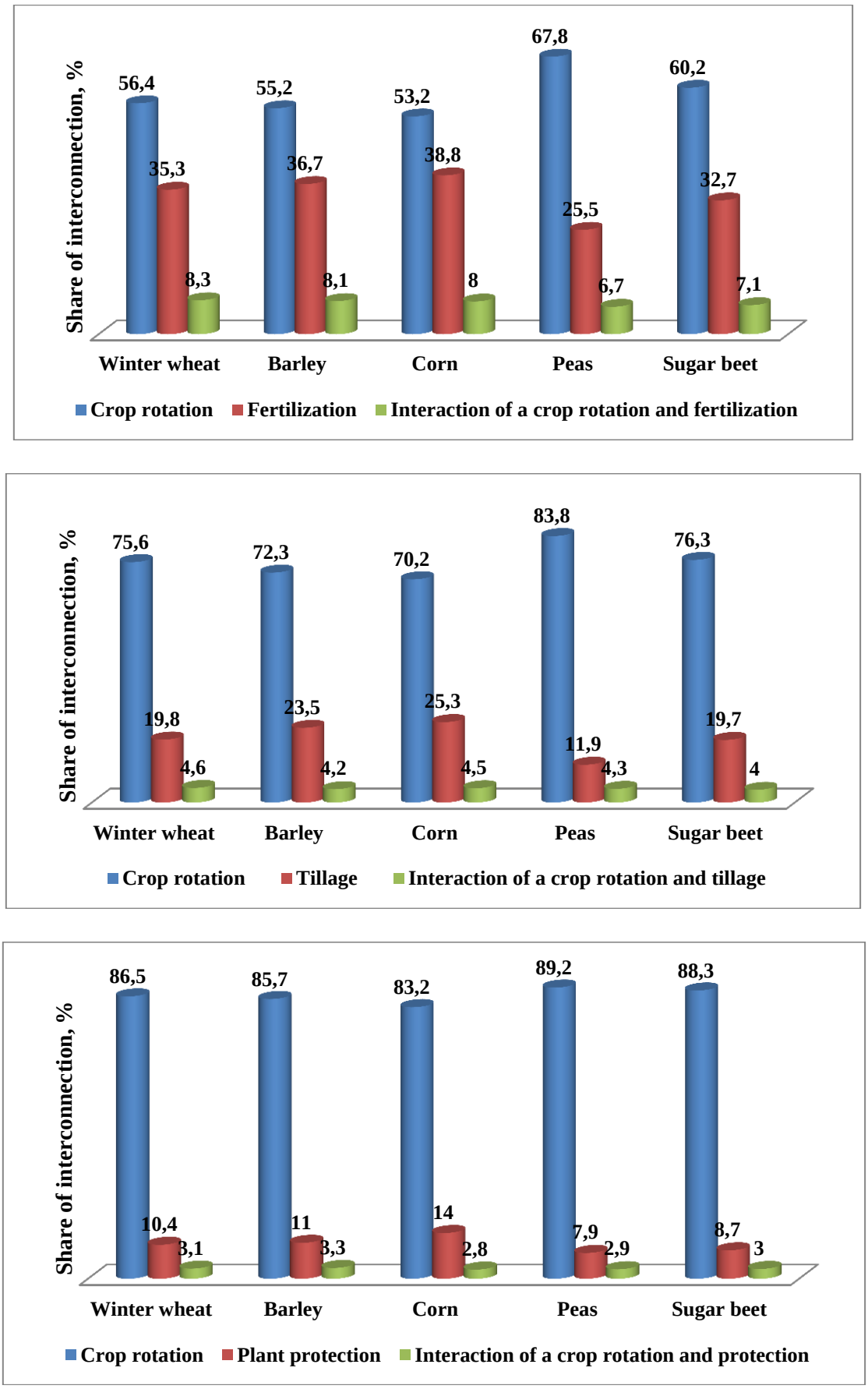


Fig. 4. A share of interconnection of a crop rotation and other factors of agriculture on the yield of the leading crops in the Forest-steppe zone of Ukraine at the beginning of the XXI century, %

As a result of processing by analysis-of-variance method of long-term data on crop capacity it has established that throughout the second half of XIX – at the beginning of the XXI centuries the interconnection share on productivity of grain crops of all agricultural factors increased, which curb negative influence of adverse weather conditions to 52 %. The effectiveness of predecessors in crop rotations substantially depended on amount of fertilizers and weather conditions. Differentiation of a way of tillage under the main cultures in a crop rotation depending on the predecessor provided increasing of efficiency of fertilization and obtaining high and stable yields of crops. Application of effective grades and hybrids, plant protection, seed preparation, seeding rate and depth and optimal periods of sowing crops was of great importance. The specified factors were among themselves in close interconnection and determined the value of the crop.

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