Қазақстан Республикасы Тәуелсіздігінің 30 жылдығына арналған «Сейфуллин оқулары – 17: «Қазіргі аграрлық ғылым: цифрлық трансформация» атты халықаралық ғылыми – тәжірибелік конференцияға материалдар = Материалы международной научно – теоретической конференции «Сейфуллинские чтения – 17: «Современная аграрная наука: цифровая трансформация», посвященной 30 – летию Независимости Республики Казахстан.- 2021.- Т.1, Ч.4 - С.148-150

EFFECTIVENESS IN FORECASTING WHEAT YIELDS USING NEURAL NETWORKS

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Introduction

The aim of the research is to justify the effectiveness of the application of neural networks in forecasting the yield of summer wheat.

Research objectives:

- review of existing work using neural networks in wheat yield forecasting;
- to identify the advantages of using neural networks in wheat yield forecasting.

Relevance of the research. Providing food to the country's inhabitants at the expense of domestic producers in modern economic conditions is becoming a priority strategy of the state, since not only food, but also the national security of the state depends on it.

The problem of food availability is particularly acute in areas with severe weather conditions, which in turn cause instability in the production of basic agricultural products, both in crops and livestock. Consequently, the need to predict probabilities assumes special importance in a situation of high uncertainty, due to both objective and subjective reasons, which is essential for making management decisions to manage the situation [1].

The use of artificial neural networks is one of the most promising methods used in research on sociological, biological, financial, economic and other complex systems.

Most scientists around the world believe that conventional methods, algorithms and models cannot be applied to solve problems of different spheres due to their unreliability and low efficiency. Therefore, this task can easily be accomplished by an artificial neural network that helps the agronomist, based on a wealth of data, to identify hidden patterns and highlight the most relevant factors.

Currently, the difficulty of forecasting is that agronomic subjective evaluation of the influence of different factors on yields is based only on its knowledge and experience, while neural networks can find algorithms with a lot of information that are often impossible for agronomists to detect.

It follows from the above that there are problems in the effective forecasting of crop yields. As a result, the development of a neural network model to predict the yield of summer wheat needs to be studied in detail.

Practical significance. A neural network-based wheat yield forecasting system can be used by agronomists for effective seed management.

Methodology. Analysis and Scientific synthesis are used. During the analysis there will be a comprehensive study of the current state of forecasting of wheat yields. Existing research experiments will be reviewed and synthesized through a scientific synthesis.

The timeliness of the problem is confirmed by the increased attention paid by the authorities to the problems of agro-industry. The President of the Republic of Kazakhstan, Kasym-JomartTokayev, in his speeches quite often addressed issues of improving the impact of power on innovation in the agro-industrial complex.A competitive economy cannot be created without strong agriculture. President Kasym-JomartTokayev said this in State of the Nation on September 1, 2020.

Literature analysis shows that there are models of neural networks to predict wheat yields based on climatic parameters, soil tillage, nutritional background, etc.

For example, a group of scientists led by Juan Cao are comparing wheat yield forecasts at county and field scales through deep learning, machine learning, and the Google Earth Engine. Karansher S. Sandhu and his collaborators compared the performance of two DL models, namely MLP and CNN, with rrBLUP to predict five different features of yeast wheat [2].

Igor Oliveira and Zehui Jiang used LSTM to construct their crop prediction model using meteorological and soil data.The difference is that the first one just kept the soil data the same in all the time steps and entered it directly into the LSTM, and the second one added soil data from a fully connected layer of its neural network model[3].

Xinlei Wang developed a deep learning model that combined remote sensing, meteorological and soil data to estimate winter wheat yields in China's main planting areas at the district level. The model was trained using trend-excluded yield statistics and evaluated by validation within one year and showed satisfactory accuracy in predicting winter wheat yields[4].

In practice, the following approaches to yield forecasting are used:

1. Statistical methods – trend analysis and cycling in yield dynamics, year-analog detection, based on synoptic process analysis.

2. Simulation modelling – construction of multi-factor regression models, non-linear dynamics methods.

The approaches of the first group are not very precise, the approaches of the second group are difficult to implement. Currently, one promising and accurate method of prediction is based on artificial neural networks.

The artificial neural network (ANN) is a mathematical model, as well as its software and hardware implementation, built on the principle of organization and functioning of biological neural networks - networks of nerve cells of a living organism. An artificial neural network successfully solves hard-to-formalize problems such as pattern and speech recognition, associative information retrieval

and associative modelsas well as forecasting their development over time, which is typical of crop series[5].

One of the main advantages of neuronetworks is that they can learn. An artificial neural network can change its behavior depending on the environment, that is, at the input a correct result will be obtained from data that were missing in the training sample or were distorted.

Crop forecasting requires taking into account the influence of various factors - basic soil and climate characteristics, use of fertilizers, rainfall, average temperature, length of vegetative period, etc.

In this way, the use of neuronetwork technologies makes it possible to forecast crop yields taking into account different factors - natural-climatic, technogenic, as well as cultivated plant species.There is no limit to the input parameters to be analyzed. Yield forecasting can minimize crop losses under adverse conditions and achieve the highest yield under favourable conditions.

Conclusion

The use of neural networks is a qualitative predictive tool. It can also be concluded that there are enough neural network models to predict wheat yields based on various parameters, but there is no neural network model to predict the influence of humus fraction on wheat yields.

Feed forward networks, or multi-layer perceptrons, have a fixed number of inputs, and each one is perceived by the others as independent. However, in recurrence networks, connections between neurons are not limited solely to the movement of information in one direction, but there is also an opportunity to return the value to "self". So the neuron can memorize information that was previously submitted to the input. This is why recurrent neural networks are the best choice for predicting time series and sequences.

The input and output tasks are divided into five options[6]:

– one way in, one way out (one-to-one);

– one input, a sequence of outputs (one-to-many);

– sequence of inputs, one output (many-to-one);

– input sequence, output sequence (many-to-many);

– synchronized input and output sequences (synchronized many-to-many).

This article solves the regression problem "many-to-one" in teacher-led learning. when using recursive layers. Ordinary recurrent networks are very poor at coping with situations when you need to "remember" something for a long time: the influence of a latent state or an input from step t on subsequent states of the recurrent network decays exponentially. That is why this study uses the LSTM (Long Short-Term Memory) model, where an additional cell is added to simulate "long memory".

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