Name of the project: IRN AP22784639 "Development of phytosanitary forecasting models for harmful grasshoppers' population in Kazakhstan based on machine learning algorithms and GIS-technologies".

Problem statement: To ensure the phytosanitary safety of the territory of Kazakhstan, a transition from a control strategy to a pest population management strategy is necessary. To manage populations of harmful organisms, it is necessary to improve methods of population prediction and observations based on remote sensing, GIS and remote monitoring methods, the use of preventive measures, including low-risk insecticides, biopesticides and biological agents.

Today, a modern plant protection specialist needs a clear and precise solution for forecasting and controlling the number of locust pests, which would be characterized by accessibility, innovation and practicality in application. Because the economic well-being and profitability of production as a whole will depend on timely response to this problem.

Currently, in the age of technology development and digitalization in the agricultural sector, there is a great need to develop models of phytosanitary forecasting of the population of harmful non-greedy locusts in the form of a digital information web application based on machine learning algorithms and GIS technologies for each agro-climatic zone of Kazakhstan for optimal decision-making on planning protective measures in real time. In addition, the competent services for phytosanitary monitoring and prediction of harmful non-invasive locusts are still guided by outdated methods. At the same time, not only are only logical population forecasts used, but weather and climate predictors are not taken into account at all when compiling them.

Due to the fact that bioinformatics and digitalization in the agricultural sector of the Republic of Kazakhstan requires specific modern innovative solutions, the development of a web application for methodological support of phytosanitary forecasting of harmful non-invasive locusts using an automated system of phytosanitary forecasting for optimal decision-making on planning protective measures is a timely solution to this problem. In our case, the development will be focused on practical application and will be a digital service for specialists of the phytosanitary monitoring and forecasting service in the annual forecasting of the number of harmful non-invasive locusts for each agro-climatic zone of Kazakhstan and, consequently, planning the volume of protective measures for the next season or year. These technical solutions and the capabilities of the web application will certainly allow you to plan the volume of protective measures more optimally, and the use of plant protection products themselves is more rational. The results of these studies will allow a wide range of scientists of the claimed field to refer to and apply them in their scientific research.

Purpose: Development of models of phytosanitary forecasting of the population of harmful grasshoppers in the form of a digital information web application based on machine learning algorithms and GIS technologies for each agro-climatic zone of Kazakhstan for optimal decision-making on planning protective measures against them in real time.

Expected results:

As per the project's objectives and its derived tasks, the following outcomes are expected:

- The collection and processing of long-term historical data on the dynamics of the number of harmful grasshoppers will be carried out to identify the features of development and reproduction in each agro-climatic zone of Kazakhstan;

- The fundamental predictors of the forecast of the number of studied pests will be identified to build a population forecast system based on machine learning algorithms for each agro-climatic zone of Kazakhstan;

- Computer-mathematical models of phytosanitary prediction of the number of harmful grasshoppers based on GIS technologies will be created for their further integration into the web application;

- A web application will be developed for methodological support of phytosanitary forecasting of harmful grasshoppers using an automated system of phytosanitary forecasting for optimal decision-making on planning protective measures.

The scientific and technical result proposed within the framework of the project is at the second level of technological readiness and upon completion of the project, the fourth level of technological readiness will be reached:

- Based on the second level of technological readiness, which includes the concept of creating forecasting models for harmful grasshoppers based on heterogeneous predictor input parameters and technological approaches, predictive models based on machine learning algorithms using GIS technologies will be developed;

- Upon completion of the project, the fourth level of technological readiness will be achieved, which includes the integration of components of computer modeling of phytosanitary forecasting, their interactive cartographic services, visualization into a full-fledged web application for practical use by industry specialists, which is the result of research activities.

Members of the research group:

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Planned publications and patents within the framework of this project:
According to the research results of 2024-2026, there will be:

- 2 (two) articles and (or) reviews will be published in peer-reviewed scientific publications in the scientific direction of the project, indexed in the Science Citation Index Expanded of the Web of Science database and (or) having a CiteScore percentile in the Scopus database of at least 50 (fifty);

- 1 (one) patent for an invention (including a positive decision on it) will be received;

- 3 (three) articles will be published in journals recommended by Education and Science Control Committee of the Ministry of Science and Higher Education of the Republic of Kazakhstan;

- 2 webinars will be held to disseminate the results of the work among potential users, the community of scientists and the general public.

- 1 user manual for using the developed web application will be published.

Information for potential users: Upon successful implementation, the project's web application will drastically increase the efficiency of phytosanitary information processing. Its aim is to minimize crop losses by accurately predicting locust population densities and strategically planning protective measures. This will optimize phytosanitary conditions, reducing pesticide usage and guaranteeing minimal agricultural losses.The pioneering technology's influence will extend beyond national borders to neighboring countries and integrate into the international phytosanitary safety system. The project represents a significant step toward a more efficient, ecologically-conscious, and effective agricultural pest control approach.

Potential users are State Inspection Committee for Agriculture of Kazakhstan and its affiliated bodies, scientific research organizations involved in agricultural matters and plant protection.

Additional information: The project, once fully realized, will introduce breakthrough technologies that will influence ecological studies, agricultural science, and plant protection. This will grant ministries, agencies, agricultural producers, scientific organizations, plant protection specialists, and other users access to accurate phytosanitary data, thus supporting informed decision-making.