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ЕНЕРГЕТИКА  
ТРАНСПОРТ АПК



*Всеукраїнський науково-технічний журнал*

**ТЕХНІКА,  
ЕНЕРГЕТИКА,  
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ЕНЕРГЕТИКА,  
ТРАНСПОРТ АПК**

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**MODERN APPROACH TO THE FORMATION OF AN OBJECT OF LEGAL PROTECTION - METHOD OF SPRAYING WITH UNMANNED AERIAL VEHICLES**

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*Inventive and patent-licensing work is an integral part of the activities of engineering, technical, and scientific workers in all spheres of the national economy. One of the results (types) of scientific and technical creativity is invention, which allows technically gifted individuals to express themselves: scientists, engineers, students, and other technical workers.*

*The use of modern technical means in agriculture, for example, unmanned aerial vehicles for technological operations, prompts the creation of new approaches and methods of their effective use, which is an urgent task for agricultural enterprises, scientific, and pedagogical workers, and students.*

*The object of the research is the method of spraying agricultural crops with unmanned aerial vehicles, as an object of legal protection.*

*The purpose of the research is to develop an effective method of spraying agricultural plants with means of protection against pests and diseases by unmanned aerial vehicles, which is the object of legal protection of industrial property.*

*The objectives of the research are to perform an analysis of the concepts of creativity and inventive activity of a person as a form of self-realization and overcoming technical contradictions; to carry out an analysis of the concepts of the object of the invention - the process (method) as an object of legal protection; study of the laws of development of technical systems and development of a utility model of the technological system of an unmanned aerial vehicle; development of a method of spraying field crops with unmanned aerial vehicles.*

*The research methodology is based on the method of materialistic dialectics, methods of analysis, and synthesis of information from official sources and scientific research.*

*As a result of the conducted research, it was established that the inventive activity of engineering and scientific workers is an integral part of the development of scientific and technical progress as a whole. The creation of fundamentally new technologies and machines, and innovative solutions in all branches of the national economy will contribute to the rapid development of our state and its entry into the system of countries with developed market relations. The object subject to legal protection is analyzed. Features of the formula for the method are described.*

*The research proposes a modern approach to the formation of an object of legal protection, namely, a method of spraying agricultural crops with unmanned aerial vehicles. The laws of the development of technical systems are considered and a utility model of the technological system is proposed, namely - the process of spraying agricultural plants with unmanned aerial vehicles. The target function of the technological system is described and the laws of development are proposed, which will allow obtaining the optimal values of the parameters of the optimization criteria.*

*The proposed method of aerial chemical spraying of plants with the use of sprayer drones allows for effective chemical treatment of plant crops and minimizes the inefficient use of shift work time associated with moving a mobile vehicle, thus increasing the productivity of UAVs.*

**Key words:** *creativity, inventive activity, invention, utility model, method, legal protection, spraying, unmanned aerial vehicle.*

**F. 1. Fig. 3. Ref. 14.**



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## 1. Introduction

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The creative activity of people, scientists, and research workers in any branch of society is one of the most powerful driving forces for the development of civilization. After all, creativity, which is distinguished by its novelty, uniqueness, originality, and socio-historical uniqueness, is a purposeful search activity of a person, the result of which is something qualitatively new.

One of the results (types) of scientific and technical creativity is invention, which allows technically gifted individuals to express themselves: scientists, engineers, students, and other technical workers.

Inventive and patent-licensing work is an integral part of the activities of engineering and scientific workers in all spheres of the national economy. After all, new knowledge on issues of legal protection and use of intellectual property, including objects of industrial property, make it possible to create fundamentally new technologies and machines, transition of the production of agricultural products to high technologies, and the entry of the state into the system of countries with market relations.

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## 2. Problem formulation

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Intellectual property rights protect various results of human creative activity. If in the commonly used understanding "creativity" is a process that brings something to life, and gives existence to something, then, from the point of view of legal science, creative activity is considered as such that can lead to the appearance of protected objects.

In modern conditions, any human activity - be it production, defense, healthcare, and so on - is simply impossible without proper scientific and technical support. For example, the socioeconomic progress of society is impossible without its spiritual development. These are closely interconnected processes, which, in turn, are interdependent. Science cannot develop successfully if production does not provide it with the necessary tools, devices, equipment, and technologies. In turn, production cannot progress without the development of science and technology.

Inventive activity is determined by the need to solve a specific technical problem to ensure the implementation of an economic or scientific task. Invention is the creation of a technological (technical) solution that meets the conditions of patentability. Such solutions can be inventions or useful models for a product or process (method).

The activity of higher education institutions in Ukraine is closely related to invention and rationalization. This especially applies to the research work of scientific and pedagogical workers, postgraduates, and students.

Therefore, the use of modern technical means and technologies in agriculture, for example, unmanned aerial vehicles for technological operations, encourages the creation of new approaches and methods of their effective use, which is an urgent task for agricultural enterprises, scientific and pedagogical workers, and students.

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## 3. Analysis of recent research and publications

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A rationalization proposal is a technical solution that is new and useful for the enterprise, organization, or institution to which it is submitted.

Rationalization is inherent in the development of human society: a person simply cannot do without improvement, without improving the tools of production, the technology of their manufacture, and all methods of expedient activity. Rationalization is carried out through various rationalization proposals.

In numerous rational proposals, only technical solutions that are expressed in the form of a change in the design of the product (device), production technology, or composition of materials are recognized as innovative by legislation [1, 2].

Rationalizing proposals are the most common type of creative activity, which in terms of accessibility and scale prevail over invention, but in terms of technical level, it is somewhat lower than it. Due to their scale, innovative proposals sometimes have a greater effect than inventions.

The result of the intellectual creativity of scientists is invention. Invention is a creative process that enables the inventor to solve a problem in a new way or to create something new that has a positive effect.

An invention is the result of creative activity, which is aimed at improving technical issues and meets the requirements of patentability. The peculiarity of the invention is that it changes the properties, structure, and function of any object. The main stage of creating an invention is the search and solution of a technical contradiction, which leads to the appearance of a new, previously unknown result.



The object of an invention (utility model), which is granted legal protection by the Law of Ukraine "On the Protection of Rights to Inventions and Utility Models" [3, 4], can be a product, a process (method), as well as a new application of a known product or process.

A process as an object of technology is an action or set of actions performed on products and other material objects with the help of at least one product and aimed at achieving a certain technical result. Such a process, in particular, is the manufacture, processing, processing of the product and its quality control, transformation of matter, energy, data, and measurement of parameters, diagnosis, treatment, and control of the process that is the object of technology.

Having established the type of object subject to legal protection, they proceed to its analysis. Analyzing a technical solution that belongs to the methods. First of all, signs that characterize the presence of operations and techniques that make up this method are written out. Then signs that characterize the sequence of operations and techniques over time are written. The characteristics of the sequence of operations must contain an indication of which operation precedes this operation or which operation it is performed on.

The final stage of the process of invention discovery is the drafting of the claims. The need to draw up the formula of the invention as a component of the description of the invention, first of all, is connected with the need to express the technical essence of the invention in a concise form and outline its boundaries, i.e. define the range of objects to which the inventor's rights in connection with the issuance security document.

The development of a method of spraying, for example by unmanned aerial vehicles means of protecting plants from pests and diseases, which is the object of legal protection of industrial property, will allow them to be effectively used in the technologies of growing crops.

Now most often spraying is carried out to protect crops from pests, diseases, and weeds with the help of chemicals. At the same time, the application of the working fluid is usually carried out by blowing it under pressure onto the treated object through the nozzles of spraying devices of self-propelled or trailed sprayers. Orientation of the flow of sprayed liquid on the sprayed object is carried out with the help of fan structures or with the help of a drone boom.

Known methods of spraying [5] involve spraying in quiet, windless, and cool weather - best in the morning after the dew has dried, and in the evening, after the sun's heat subsides. During the period of spring frosts, spraying is carried out in such a way that the plants have time to dry before the evening. The spraying of crops on large areas is carried out by ground means of mechanization or, if conditions allow, with the help of agricultural aviation equipment. The wind speed during spraying should be minimal - to reduce the wear of the working fluid in neighboring areas.

This method generally satisfies the requirements of spraying measures, but at the same time, it has several technological and technical limitations that reduce the effectiveness of its application. It is not possible to spray plants during dew, during light rain, and when the wind speed exceeds 4-5 m/s. Already at wind speeds from 2-3 to 5 m/s, the spraying device must move only in a certain direction and in a clearly defined orientation in relation to the direction of the active wind, which is not always allowed by the configuration of the field and the peculiarities of its relief or the nature of the orientation of the rows landing. When using a field boom, it is installed at a height of 0.4-0.5 m from the cultivated crop.

The known aviation spraying system "AMO-3" [6] contains an aircraft with liquid spraying, and each liquid atomizer together with the aircraft forms a spherical kinematic pair. However, the disadvantage of this aviation system is the limitation in maneuvering and the unregulated execution of the technological process under different soil and climatic conditions.

For spraying, can be also used a robotic complex for automated aerial chemical treatment of plants [7]. This complex includes a sprayer drone, which is made in the form of a small-sized multi-screw automatic unmanned aerial vehicle, as well as a service ground mobile technological device. The disadvantage of such a technological complex for aerial chemical treatment of plants with the use of sprayer drones is an overly complex technological scheme for processing fields, as well as a lack of coordination of interaction when using two or more aircraft.

It should also be emphasized that when spraying crops with a UAV, the drone operator cannot always form a rational route for the flight task or choose places for recharging the batteries and pouring the working solution.

It is possible to increase the effectiveness of field crop spraying by UAVs due to taking into account the mentioned shortcomings.





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#### 4. Aim of the researches

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The aim of the research is to develop an effective method of spraying agricultural crops with unmanned aerial vehicles using plant protection agents to safeguard them against pests and diseases, which is also an object of the legal protection of industrial property.

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#### 5. Results of the researches

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The main difference between a rationalizing proposal and an invention is the nature and degree of novelty [8]. An invention requires absolute (global) novelty, while an innovative proposal requires local (limited) novelty. The invention is characterized by significant differences from the prototype, while this requirement does not apply to an innovative proposal.

The objects of the rationalization proposal are constructive changes in products, technological processes (methods), and substances (composition of materials). But rationalization is not limited only to these points, it can refer to proposals from any sphere of human activity.

Subjects of the right to an innovative proposal, as intellectual property, are its author and the legal entity to which the proposal was submitted [9]. The author (rationalizer) of the proposal is considered to be the person who created it based on his creative work. If the innovative proposal is created by the creativity of several people, then they are considered co-authors, and the procedure for using the right to the innovative proposal is determined by the agreement concluded between the authors. If a person provided only technical assistance, that is, helped with the preparation of documents, carried out calculation or drawing work, then they are not considered a co-author.

In practice, two types of idealization are distinguished in invention:

- 1) the number of functions remains unchanged, and the mass, dimensions, and energy consumption of the system approach zero;
- 2) the number of functions increases, while the mass, dimensions, and energy consumption remain unchanged.

Based on the analysis of the descriptions of inventions from the patent fund of the leading countries of the world, Heinrich Altshuller managed to establish in the 1960s that the inventions that determine the development of technology are created as a result of overcoming technical contradictions. He singled out 40 basic and 100 additional typical principles for solving technical contradictions, which made it possible to overcome typical inventive problems.

To obtain standard solutions to inventive tasks, it is necessary to combine typical methods of solving contradictions and phenomena that occur based on the laws of the development of technical systems. Knowing the object of the invention, it is possible to establish its principle of operation, whether the technical solutions of the object correspond to the laws of development of technical systems, it is possible to set the task of increasing the level of idealization for the entire object or technological process.

The algorithm for solving inventive tasks consists of three stages [10 11]:

1. Analytical – choosing a task, determining its main chain, identifying a decisive contradiction, and finding its cause.
2. Operative – a study of typical solutions that exist in nature or technology, search for new solutions by making changes within the system, in the external environment, or adjacent systems.
3. Synthetic – introduction of functionally determined changes to the system, and methods of using the system.

Another effective method is the modernization of technical systems, which is also based on the theory of invention. This technique is used to increase competitiveness. To use this method, a patent search is conducted to identify existing leading analogs. Then, the technical indicators of these analogs are studied, and an analysis is performed to determine whether these objects are competitive. Next, they determine the basis of which these objects have such indicators, set an inventive task to modernize the object and formulate a technical contradiction, using the methods and means of the theory of invention to solve it.

An invention, as a result of human intellectual activity, has an intangible nature but is embodied in material objects. The Law of Ukraine "On the Protection of Rights to Inventions and Utility Models" [3, 4] establishes that the objects of inventions can be a product (a device, a substance, a strain of a microorganism, plant, and animal cell cultures, etc.), a method, an application of a previously known product or a method for a new purpose.

An invention can be considered anything that is the result of human activity, the essence of which is to find technical solutions and tasks that arose in the process of researching any issues.



An invention is a new solution to a problem that has an inventive level and a useful application. The objects of inventions can be a device, method, substance, or strain of a microorganism, plant, or animal cell culture, as well as the use of a previously known device, method, substance, or strain for a new purpose [3, 12].

All modern mechanisms for solving inventive tasks are based on the laws of the development of technical systems. They were first formulated by the inventor Heinrich Altshuller.

The laws of development of technical systems are divided into 3 stages [13, 14]:

1. Statics (the beginning of the system's existence):

- Law of completeness of system parts;
- Law of «energy conductivity» of the system;
- Law of coordination of parts of the system;

2. Kinematics (the heyday of the development of technical systems):

- Law of increasing degree of ideality;
- Law of uneven development of parts of the system;
- Law of transition to the supersystem;

3. Dynamics (final stage of development of technical systems and transition to a new system):

- Law of increasing the degree of dynamism of systems;
- The law of transition from the macro level to the micro level;
- Law of increasing versatility of the system;
- Law of the transition to controlled resources and increased manageability.

We will use some of these laws when developing a model of the UAV technical system to solve the production problem.

The use of unmanned aerial vehicles (UAVs) in agriculture has great potential, and interest in their use only grows every year. Currently, UAVs are actively used to determine the boundaries of land plots and cadastral accounting.

Nowadays, the use of the latest technologies by agricultural enterprises is a necessary step for successful work. A scientific approach to the implementation of remote monitoring systems from geoinformation systems helps to quickly and accurately assess the condition of the soil cover, reduce the amount of fieldwork and apply scientifically based norms for the application of mineral fertilizers or plant protection products. Such technologies contribute to the reduction of financial costs, time costs and increase the productivity of cultivated crops.

As is known, spraying is a technological process in which a working fluid is artificially applied to the treated (sprayed) object in the form of finely dispersed droplets that cover the corresponding treated surface of the object. The working fluids used for spraying are various dispersed systems: homogeneous substances, solutions, suspensions, emulsions, etc.

Thus, the technological process of spraying can be considered a technological system that includes at least four elements:

- 1) spraying agent (working fluid);
- 2) sprayed object;
- 3) a device for using a spraying agent;
- 4) spraying environment.

A technological system is a combination of functionally interdependent means of technological equipment, production objects, and performers, designed to carry out specified technological processes and operations under regulated conditions [13, 14].

Technological systems belong to the class of process systems and they can be at the level of operations, process, and technology of the complex. They include technical and management personnel.

The technological system of the UAV is a system of the type "man - object of work - information means and environment". Technical and technological systems exist in a close functional relationship.

To solve a production problem, namely, spraying cultivated plants with plant protection products using a UAV, it is necessary to assess the situation and identify contradictions and inconsistencies, cause-and-effect relationships, etc. Such information is obtained as a result of the analysis of the situation, system, or its indicators.

To create a modern UAV system, we define the objective function (OF). By using techno-economic analysis, we can identify that the OF is to reduce operational costs and increase the UAV's efficiency by the established operation regulations. The mathematical expression of the objective function can be represented as:



$$OF = \Sigma OS \quad (1)$$

provided that  $Q_j \rightarrow \min$  and  $N_{ij} \rightarrow \max$ ,

where  $Q_j$  – costs;  $N_{ij}$  – number of output parameters;  $\Sigma OS$  – set of parameters of the research object.

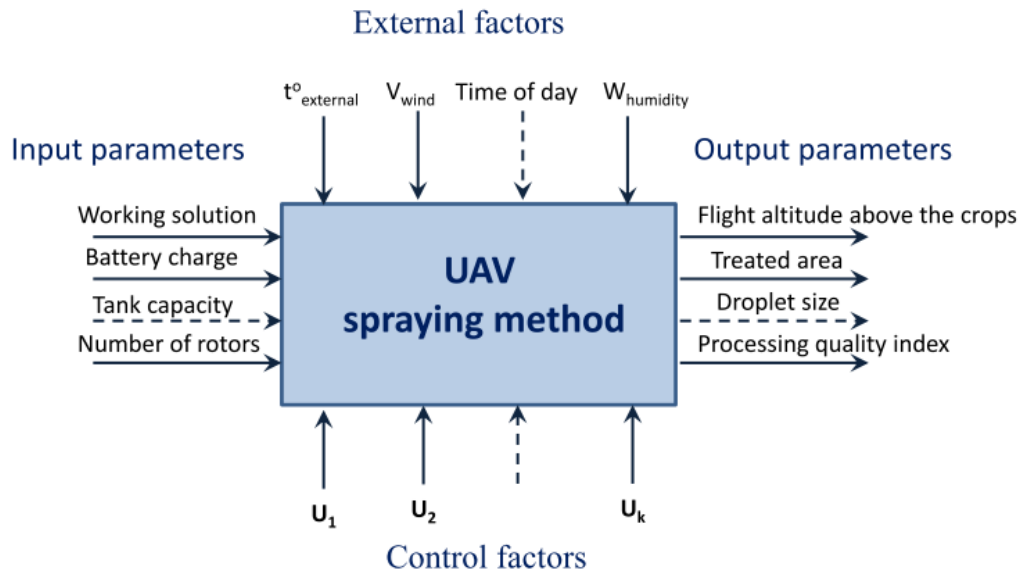
The technical and economic analysis makes it possible to reveal the effectiveness of the introduction of new equipment and technologies, the organization of work, and management.

The model of the UAV technological system can be represented as shown in Fig. 1.

As a rule, technological and production systems for agricultural purposes are classified as complex dynamic systems. To a large extent, the complexity of the system depends on the depth of its structuring (degree of detail).

In general, the UAV technological system should be considered a controlled system. Control functions are performed by a human operator. Information flows to the UAV control object are transmitted in the form of management decisions using the control panel, and feedback is carried out based on monitoring the flow of the technological process.

Performance of the target function of UAV operation with optimal parameter values is possible when considering the laws of development of technical systems, namely: the law of increasing the degree of ideality; the law of transition to the supersystem; the law of uneven development of parts of the system; the law of increasing the degree of system dynamism and the law of transition to controlled resources.



*Fig. 1. Model of the technological system*

The basis of the idea is the task of improving the method of aerial chemical spraying of plants using sprayer drones, by forming a rational flight task that will increase the performance of UAVs.

The task is solved because the method of aerial chemical spraying of plants includes the use of sprayer drones, which are made in the form of a small-sized multi-screw automatic unmanned aerial vehicle with a tank capacity of 16-30 liters, and a mobile technical vehicle (Fig. 2) for transportation sprayer drones, a charging station, batteries, a device for preparing a working solution. The proposed method involves one operator and one assistant, as well as at least two drone sprayers. These drone sprayers take turns refilling with the chemical liquid from the solution preparation device. Depending on the size of the field, the spraying zone, as well as the amount of chemical liquid introduction, are variable and are consistent with the technical conditions of their use. The team, which includes one operator and an auxiliary worker, and two spraying drones, when spraying the area, is located on one side of the field and includes at least several base points for refueling and recharging the spraying drones (Fig. 3). In this method, the drone sprayers take off from a single base point and move in different directions across the working area during the spraying process. They move left and right or follow another field task route, while each drone covers its designated working area. The maximum displacement of spraying drones to the left or right of the base point does not exceed 250-300 m. For effective work, the field is divided into several sections (sections 1, 2, 3, etc.).

When treating areas with a chemical substance, mobile team 1 is located on one side of the field, which includes at least several base points 2, 3...n (Fig. 3) for refueling and recharging spraying drones. At the same



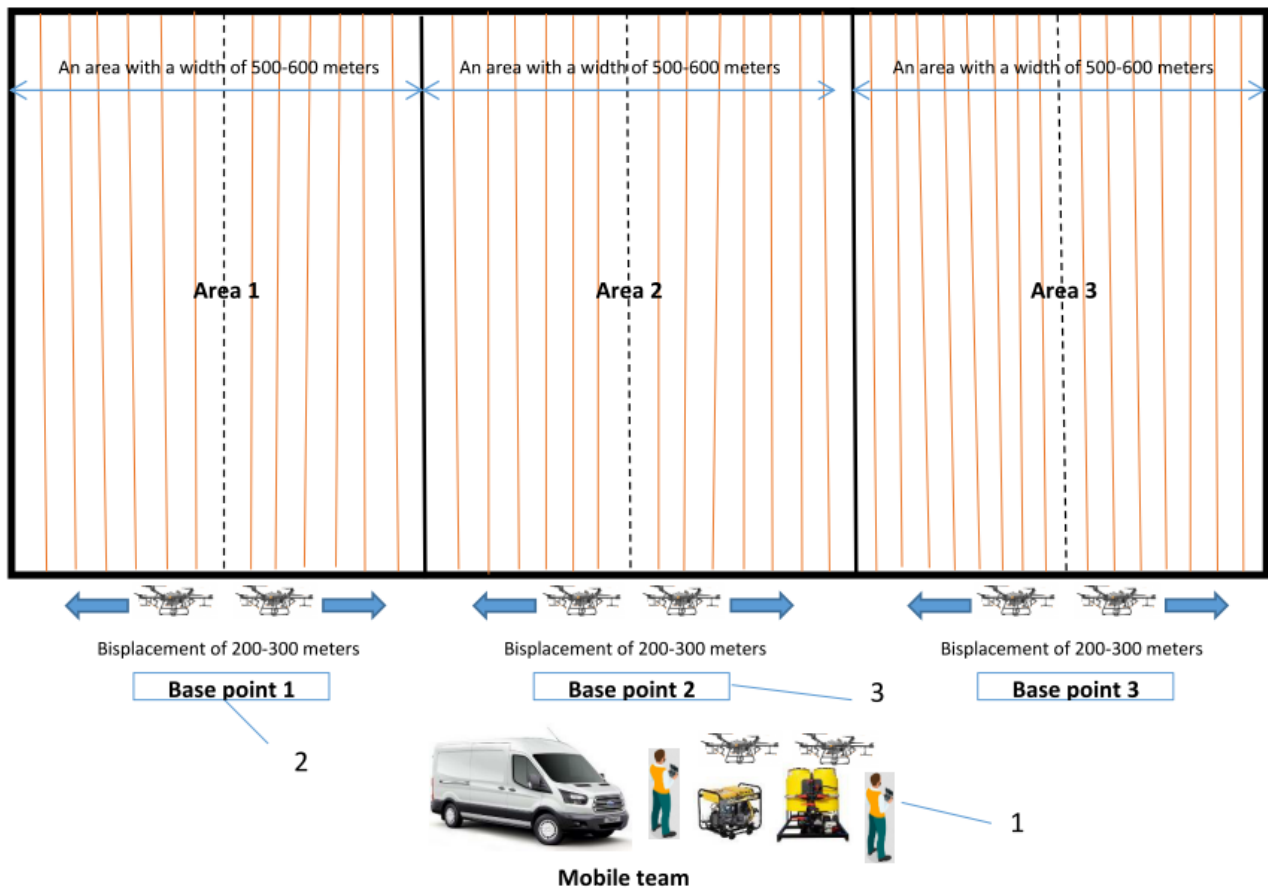
time, refueled spraying drones can simultaneously or with a delay rise above the surface of the field and carry out chemical treatment of the plants of their planned working areas according to the field task (mission).



**Fig. 2. The composition of the mobile team when spraying crops**

Meanwhile, when the spraying drones perform a reciprocating movement, ensuring the treatment of crop areas, at base points 2 and 3, the working solution is prepared and the batteries are recharged.

When the spraying drones complete the working areas, the mobile vehicle moves from base point "1" to base point "2" (Fig. 3) for a distance of at least 500-600 m.



**Fig. 3. Scheme of UAV flights**

The proposed method of aerial chemical spraying of agricultural plants using UAVs will allow effective chemical treatment of crops and minimize inefficient use of shift work time associated with moving mobile vehicles, thus increasing their productivity.



## 5. Conclusions

1. The inventive activity of engineering and scientific workers is an integral part of the development of scientific and technical progress as a whole. The creation of fundamentally new technologies and machines, and innovative solutions in all branches of the national economy will contribute to the rapid development of our state and its entry into the system of countries with developed market relations. Inventive activity is determined by the need to solve a specific technical problem to ensure the implementation of an economic or scientific task. Problems may be related to the release of new products with predetermined properties, expansion of functions or increase in productivity (stationary equipment or aggregates), reduction of energy consumption, increase in reliability of technical systems, etc.

2. The analysis of the object eligible for legal protection has been conducted. The peculiarities of the invention formula for the method have been described.

3. scientific research proposes a modern approach to the formation of an object eligible for legal protection, specifically, the method of spraying crops using unmanned aerial vehicles. The laws of development of technical systems have been examined, and a model of the technological system for the process of spraying crops with unmanned aerial vehicles has been proposed. The objective function of the technological system has been described, along with the proposed laws of development that will enable obtaining optimal values for the parameters of optimization criteria.

4. The advantages of using unmanned aerial vehicles (UAVs) for spraying are justified, which include the absence of soil compaction and damage to crops, the ability to work immediately after rain, and the ability to spray areas with challenging topography. The proposed method involves one operator and one assistant, along with at least two drone sprayers that take turns refilling with the chemical liquid from the solution preparation device. Depending on the size of the field, the spraying zone and the volume of chemical liquid application are variable and adjusted according to the technical conditions of their use. The proposed method of aerial chemical spraying using drone sprayers enables efficient chemical treatment of plant crops and minimizes the inefficient use of shift time associated with the mobile vehicle's movement. This, in turn, increases the productivity of UAVs (Unmanned Aerial Vehicles).

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#### СУЧАСНИЙ ПІДХІД У ФОРМУВАННІ ОБ'ЄКТА ПРАВОВОЇ ОХОРОНИ – СПОСІБ ОБПРИСКУВАННЯ БЕЗПІЛОТНИМИ ЛІТАЛЬНИМИ АПАРАТАМИ

*Винахідницька і патентно-ліцензійна робота є невід'ємною частиною діяльності інженерно-технічних і наукових працівників в усіх сферах народного господарства. Одним із результатів (видів) науково-технічної творчості є винахідництво, що дозволяє самовиразитись технічно обдарованим особистостям, а саме: вченим, інженерам, студентам та іншим технічним працівникам.*

*Використання сучасних технічних засобів у сільському господарстві, наприклад, безпілотних літальних апаратів для виконання технологічних операцій, спонукає створювати нові підходи та способи їх ефективного використання, що є актуальним завданням для сільськогосподарських підприємств, науково-педагогічних працівників і студентів.*

*Об'єктом дослідження був спосіб обприскування сільськогосподарських культур безпілотними літальними апаратами, як об'єкт правової охорони.*

*Мета роботи полягала у розробці ефективного способу обприскування безпілотними літальними апаратами сільськогосподарських рослин засобами захисту рослин від шкідників та хвороб, що є об'єктом правової охорони промислової власності.*



*Завданням роботи передбачалось: виконати аналіз понять творчості та винахідницької діяльності людини як виду самореалізації та подолання технічних протиріч; здійснити аналіз понять об'єкта винаходу – процес (спосіб), як об'єкта правової охорони; дослідження законів розвитку технічних систем та розробка моделі технологічної системи безпілотного літального апарата; розробка способу обприскування польових культур безпілотними літальними апаратами.*

*Методика досліджень заснована на методі матеріалістичної діалектики, методах аналізу та синтезу інформації з офіційних джерел та наукових досліджень.*

*В результаті проведених досліджень було встановлено, що винахідницька діяльність інженерно-технічних і наукових працівників є невідомою частиною розвитку науково-технічного прогресу в цілому. Створення принципово нових технологій і машин, інноваційні рішення в усіх галузях народного господарства сприятимуть швидкому розвитку нашої держави та входження її в систему країн із розвинутими ринковими відносинами. Здійснено аналіз об'єкта, який підлягає правовій охороні. Описано особливості формули винаходу на спосіб.*

*У роботі запропоновано сучасний підхід до формування об'єкта правової охорони, а саме – спосіб обприскування сільськогосподарських культур безпілотними літальними апаратами. Розглянуто закони розвитку технічних систем та запропоновано модель технологічної системи – процес обприскування сільськогосподарських рослин безпілотними літальними апаратами. Описана цільова функція технологічної системи та запропоновані закони розвитку, які дозволять одержати оптимальні значення параметрів критеріїв оптимізації.*

*Запропонований спосіб авіаційного хімічного обприскування рослин із використанням дронів-обприскувачів дозволяє ефективно здійснювати хімічну обробку посівів рослин та зменшити до мінімуму неефективне використання робочого часу зміни, що пов'язано з переїздами мобільного транспортного засобу, підвищуючи таким чином продуктивність БПЛА.*

***Ключові слова:** творчість, винахідництво, винахід, корисна модель, спосіб, правова охорона, обприскування, безпілотний літальний апарат.*

***Ф. 1. Рис. 3. Літ. 14.***

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