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THE IMPORTANCE OF USING DRONES IN MONITORING AGRICULTURAL CROPS

Maxfuza T. Abdullayeva
Scientific Researcher Of The State Scientific Design Institute "Uzdaverloyiha",, Uzbekistan

G'Ofurjon T. Parpiyev
Doctor Of Biological Sciences, Senior Researcher Deputy General Director Of "Uzdaverloya", Uzbekistan

ABSTRACT

This article presents a comparative analysis and monitoring of remote sensing of agricultural crops using various methods based on modern digital technologies.

KEYWORDS

Unmanned aerial vehicles (UAVs), electronic map, agriculture, acreage, monitoring, satellite image, remote sensing.

INTRODUCTION

Nowadays, using drones in agriculture has begun to develop rapidly, and the issue of introducing these technologies into production is becoming urgent. Modern technical support, such as spectral cameras, makes drone technologies more informative and significantly expands their scope of application [1,2,3].

In agriculture, the following tasks can be solved with the help of unmanned aerial vehicles: creation of electronic maps of fields, (construction of 3D model of fields), inventory of agricultural land; there were rations for estimating the volume of work and monitoring their implementation, optimal construction

of irrigation systems; operational monitoring of crop conditions; monitoring the normalized vegetation index NDVI (Normalized Difference Vegetation Index) for efficient application of fertilizers; crop germination assessment, crop yield prediction, agricultural land environmental monitoring, agricultural land protection, spraying of chemicals to control pests and diseases; assessment of the chemical composition of the soil [4].

THE MAIN FINDINGS AND RESULTS

Technological equipment and high accuracy of operations allow quadcopters to be used on a large scale. In particular, the scale of use of agrodrones in agricultural production practice is expanding. They are also high-tech devices with a technologically simple design and principle of operation.

The main advantages of agrodrones are follows:

- Less time consumption. Tests and practical use of drones show that due to the wide spray zone, they can process 4-6 hectares of land in 20 minutes of flight.

- Functionality. Equipped with a large liquid tank and sprayer, the aircraft can transport pesticides or fertilizers to the field and hard-to-reach areas, and spray their doses accurately and uniformly.

- Saving money. Reducing the cost of using special equipment and fuel.

- Mobility. Agrodrones can quickly bypass obstacles, so they can be used in gardens, forests, mountains.

Wide capacity. Different methods and different systems are provided to build a route for drones to work effectively. In addition, agrodrones can automatically record breaks, return to the starting point, and resume work from the previous place.

The ease of use of an airplane type drone can be done by anyone with a little practice.

Disadvantages of drones. Despite all the positive aspects, drones have a number of disadvantages:

- Depending on the operations performed by the Agrodron, the limited flight time does not exceed 40 minutes.

- Load lifting capacity of about 12 kg.

- The volume of the tank is up to 12 liters.

- Depending on the weather conditions, the agrodrone can only be stopped by moderate snow or rain and wind blowing at a speed of up to 8 m/s.

Practical experience of recent years shows that investments made in the first year of active use of agrodrones in agriculture bear fruit. Recently, there has been a gradual decrease in the price of drones and an increase in the number of offers of professional services using drones.

R.A. Turaev in crop monitoring [5,6], indicated the following types of using drones in agriculture:

- monitoring the quality of irrigation and drip irrigation of irrigated fields using irrigation machines;

- field monitoring in order to identify animals that have fallen into the area (to protect them from damage);

- by monitoring the location and use of agricultural machinery, in particular, by monitoring the directions of machines in the field, it will be possible to quickly assess the quality of the work of mechanizers. Quality control of cultivated areas;

- construction of land reclamation, monitoring of irrigation systems;

- feeding livestock, searching for stray animals from the herd, directing them to the herd;

- detection of sick animals in the herd using a drone equipped with a thermal camera and necessary software;

- to create electronic maps of sites, the final product is a high-resolution orthophoto plan and, based on it, to create vector maps that illuminate the information required by the customer;

- registration of crops and fields, hayfields, pastures, perennial grasses, mines, which determine the objective area of arable land and arable land;

- creation of topographic plans;

- monitoring of irrigated crops without harming them;

- use in fire analysis, fire monitoring;

- introduction of chemicals into selected, polluted areas of the mine;

- assessment of the growth of weeds and other pests or algae in water supply systems or water bodies;

- assessment of the scope of work and continuous control of their implementation;

- documentation of damage caused by natural disasters.

Compared to the traditional method, there is a sharp difference in the monitoring of agricultural land in modern methods. For example, if we describe the monitoring of 500 hectares of agricultural land using various methods, then in the traditional method, 4 days are spent on field work by 4 land surveyors, 6 days are spent on data processing, and the cost required for monthly wages is 9 mln. soum.

In addition, when a quadcopter (Phantom 4 pro+) drone is used for 500 ha of agricultural land, 6 hours of field work and 4 hours of data processing are spent by 2 land surveying operators, and the cost required for monthly salary is 900,000 soums [5].

According to our comparative analysis of remote sensing of 1000 ha of agricultural cropland using different methods, it can be expressed as following.

1. By traditional method – the time spent is 5 days, 4 land surveyors are required according to the manpower and position, it is found that 5 days will be spent on data processing. From this, the monthly salary was 8,800,000 soums, the level of accuracy of the obtained information was found to be 70-85%. The positive side is almost imperceptible, because the human factor is very high. Because it takes 10 days to process the data.

2. By using a quadcopter equipped with an optical and multispectral camera (Foxtech Hover 1 FH 310Z) – it takes 8 hours, requires 2 land surveying operators according to the manpower and position, and also spends 4 hours on data processing. Out of this, the monthly salary is 880,000 soums, the level of accuracy of the information obtained is 99%. The upside is very high.

1) no special place is required to launch the device;

2) it is effective to use in small fields (up to 500-1000 hectares);

3) it is possible to create an electronic digital map of agricultural arable land with an accuracy of 7 cm;

4) the ability to obtain quick information on the types of plants in the pasture, their condition, and the level of disease on the basis of processed spectral data;

5) forms a database for the creation of artificial intelligence, which allows to obtain online information on the condition of agricultural land, areas of distribution of plants and other information;

6) it is possible to upload processed data directly to the geoportal of the Ministry of Agriculture of Uzbekistan;

7) the high accuracy of the created digital maps allows for the implementation of project work;

8) no influence of the human factor.

Negative aspects:

1) flight duration is 40 minutes;

2) recharging need;

3) after the end of the maintenance period, it needs to be repaired;

4) cannot be used in adverse weather conditions (windy, snowy, rainy days).

3.   Cartographic drone-Foxtech AYK-250 VTOL Inspection Combo – it takes 2 hours, requires 3 land surveying operators according to manpower and position, and 4 hours is spent on data processing. Of this, the monthly salary is 880,000 soums, the level of accuracy of the information obtained is 99%. The upside is very high.

1) it is effective to use for large areas (1000 ha and more);

2) it is possible to create an electronic digital map of agricultural arable land with an accuracy of no less than 5 cm;

3) it is possible to upload the processed data directly to the geoportal;

4) the high accuracy of the created digital maps allows for the implementation of the project;

5) no influence of the human factor.

Negative aspects:

1)   after the end of the maintenance period, it needs to be repaired;

2)   cannot be used in adverse weather conditions (windy, snowy, rainy days).

4.   Satellite images – it takes 40 minutes, requires 1 land surveyor according to the manpower and position, and 4 hours are spent on data processing. The monthly salary is 220,000 soums. The positive side is very high.

1) it is possible to obtain an unlimited number of agricultural land surveys in terms of a unit of time;

2) it is possible to create an electronic digital map of agriculture with an accuracy higher than 50 cm;

3) has the ability to receive information quickly compared to drones;

4) it is possible to upload the processed data directly to the geoportal;

5) no influence of the human factor.

There are also negative aspects of this method. For example:

1) it is necessary to purchase a space photo;

2) purchased space photo will need processing;

3) does not give clear results in adverse weather conditions (cloudy, snowy, rainy days);

4) the space map of agricultural land is updated every six months;

5) the accuracy of free space photography is low;

6) the purchase price of average resolution space photo is about $12.5 per 100. This is equal to 1,382,000 soums per 1,000 ha (as of May 10, 2022).

Overall 8,800,000 soums are spent on 5 land surveyors in a total of ten days along with materials processing in the traditional way, while the cartographic drone-Foxtech AYK-250 VTOL Inspection Combo method is used, a total of 880,000 soums are required for 3 land

surveyors in 6 hours. The main thing is that the accuracy of the data is 99%.

In general, with the help of such modern technologies, a 65% reduction in the impact of the human factor in agricultural land monitoring is achieved [5].

You can also fly multiple drones simultaneously to get more information. Because there are no big airfields or other similar obstacles to launch drones. Modern programs and data from drones make it possible to form and regularly update the geoinformation system in a short period of time.

Table 1

Comparative analysis of remote sensing of 1000 ha agricultural cropland using different methods

#	Methods of remote sensing	Time spent (day, minute)	Labor force and position	Data processing	Expenses (daily) required on the basis of monthly salary, in soums	The degree of accuracy of the obtained information, %	Main features	
							Advantages	Disadvantages
1	Traditional method	3 days	1 land surveyor	1 day	300 000	70-85	-	1. It takes 9 days to process the data. 2. The human factor is high.
2	Quadrocopter equipped with optical and multispectral camera (Foxtech Hover 1 FH 310Z) *Price:* *With an optical camera - 28 mln. soum.* *With a multispectral camera - 90 mln. soum.*	8 hours	2 land surveyors	4 hours	660 000	99	1. No special place is required to launch the device. 2. It is effective to use in small fields (up to 2500 hectares). 3. It is possible to create an electronic digital map of agricultural arable land with an accuracy of up to 7 cm. 4. On the basis of the processed spectral data, it is possible to obtain quick information about the types of agricultural crops, their condition, and the level of disease. 5. Forms a database to create artificial intelligence that allows for online retrieval of agricultural crop status, vegetation coverage, and other information. 6. It is possible to upload the processed data directly to the geoportal. 7. The high accuracy of the created digital maps allows for the implementation of land surveying projects. 8. No influence of the human factor.	1. The duration of the flight is 40 minutes. 2. It will need additional power. 3. At the end of the maintenance period, it will need to be repaired. 4. It cannot be used in adverse weather conditions (windy, snowy, rainy days).
3	Cartographic drone-Foxtech AYK-250 VTOL Inspection Combo *Price:* *161 mln. soum.*	2 hours	3 land surveyors	4 hours	880 000	99	1. Large size 2. (1000 hectares and more) is effective for application. 3. It is possible to create an electronic digital map of pastures with an accuracy of no less than 5 cm. 4. It is possible to upload the processed data directly to the geoportal. 5. The high accuracy of the created digital maps allows for the implementation of project work. 6. No influence of the human factor.	1. At the end of the maintenance period, it will need to be repaired. 2. It cannot be used in adverse weather conditions (windy, snowy, rainy days).

#	Methods of remote sensing	Time spent (day, minute)	Labor force and position	Data processing	Expenses (daily) required on the basis of monthly salary, in soums	The degree of accuracy of the obtained information, %	Main features	
							Advantages	Disadvantages
4	FOXTESN TNEA 130 (spray drone)	It flies for 20 minutes per 1 charging	2 land surveyors	-	660 000	-	1. The possibility of agrochemical processing from a height of 3-4 meters without causing physical damage to plants (without touching them); 2. 10 liter of liquid mass - processes 1.0 hectares in 20 minutes with chemical means; 3. while moving in one direction, it moves by spraying liquid from a height of 3-4 meters in a width of 3-5 meters. 4. With the help of 1 spray drone, it is possible to carry out agrotechnical activities with the help of chemicals on crops on an area of up to 24 hectares in one day.	1. The duration of the flight should not exceed 20 minutes; 2. The capacity of the suspension tank does not exceed 10 liter; 3. It cannot be used in adverse weather conditions (windy, snowy, rainy days).

It is a specialized agrotechnical drone with a perfect spraying system, designed for seed and liquid spraying, plant protection, as well as trichogram spraying activities developed in biological laboratories.

- 10 liter of liquid mass - treats 1.0 hectares of land in 20 minutes with chemical means;

- while moving in one direction, it moves 7-10 meters wide by spraying liquid.

- it is possible to carry out agrotechnical activities with the help of chemicals on crops on an area of up to 24 hectares in one day.

CONCLUSIONS

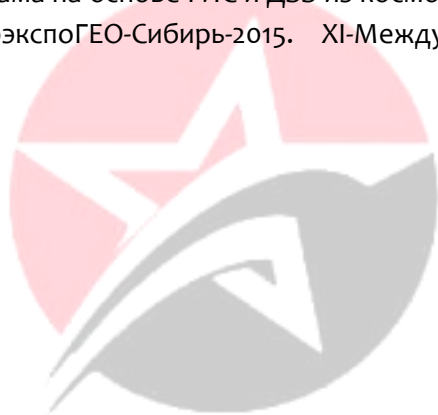Hence, it indicates the superiority of the human factor in traditional monitoring studies. In addition, it is worth mentioning here that monitoring studies carried out by the land surveyor require a certain amount of time. And, of course, in this respect, these cases do not fully correspond to today's requirements.

Organization of monitoring of agricultural crops on the basis of digital technologies is, firstly, monitoring and quick analysis of data, saving time, secondly, less manpower is required, thirdly, excessive spending of funds is avoided, and finally, data reliability is achieved.

Depending on the natural and climatic conditions, the accuracy level of data is 70-100% using the quadcopter and cartographic drone Foxtech AYK-250 VTOL Inspection Combo equipped with optical and multispectral camera (Foxtech Hover 1 FH 310Z) or satellite images.

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