Introduction of Elements of Precision Farming on the Basis of Unmanned Air Cargo Platforms in the Conditions of Mountain Winemaking*

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Abstract. The paper analyzes modern systems of farming and viticulture. A comparative assessment of traditional technogenic and precision viticulture is carried out. The fundamental features of the introduction in the southern regions of Russia of the latest high-tech elements of precision viticulture, including unmanned aerial platforms for vertical takeoff and landing SKYF, in the conditions of mountain winemaking have been determined. The identified advantages of using unmanned technological equipment will significantly improve the quality of wine products by reducing the time between grape harvest and processing and preserving the ecology of the environment, thanks to the environmental friendliness of SKYF unmanned platforms. The introduction of modern technical means of logistics, monitoring, and management systems is called upon to ensure the greatest efficiency of viticulture in the southern regions of Russia.

Keywords: Unmanned Aerial Cargo Platform for Vertical Take-Off and Landing, Grapes, Transportation, Processing, Unmanned Cargo Aerial Platform Control, Flavones, Hydroxycinnamic Acids, Hydroxybenzoic Acids.

1 Introduction

Agriculture has always been one of the most important sectors of the economy of the southern regions of Russia. Agriculture accounts for about 17% of the gross regional product. The agriculture of these regions is historically focused on the development of agriculture. The branches of his specialization are viticulture, gardening, cultivation of tobacco, essential oil crops, and grain farming. Thus, Crimea in 2014 ranked 3rd in Russia in terms of the gross harvest of grapes (13.4% of the gross harvest of grapes in Russia), was in the top ten regions in terms of the gross harvest of berries and fruits

(7th place), and vegetables (10th place), twenty in sunflower seed production (19th place), thirty in gross grain harvest (27th place) [1-6].

Global climate change caused by human impact on the environment, chemical and technogenic intensification of agriculture, emission of carbon dioxide, lead dioxide, and other harmful gases into the atmosphere that harm human health, leads to the reassessment of traditional systems of agriculture and viticulture and the development of new systems. Such systems are based on the biologization and ecologization of intensification processes in agroecosystems and agrolandscapes, mobilization of the adaptive potential of the most important biotic components of agrobiogeocenoses, more differentiated use of natural, biological, and technogenic resources [7-12].

Scientific and technological progress in the development of robotics, microelectronics, information, and telecommunications technology, the creation of positioning systems, and geoinformation systems have laid the fundamental foundations for the development and implementation of agricultural technologies differentiated in space and time. This qualitatively new, innovative technological complex was called "precision agriculture" [13-18].

In the subtropical conditions of the northern coast of the Black sea, where the best European grape varieties Vitis Vinifera grow and wines with a worldwide reputation are produced, the vineyards are mostly located in mountainous areas. This causes an increase in the economic costs of transporting grapes in the absence of high-quality transport infrastructure, an increase in delivery time from the moment of grape harvest until the moment of its processing, which leads to a decrease in the quality of raw materials supplied for processing [19-22].

The purpose of the article is to compare the functionality of unmanned air cargo platforms in the conditions of mountain winemaking.

2 Main Content

Currently, more and more attention is paid to the issue of obtaining wines with high antioxidant properties that have a beneficial effect on human health [23-25].

According to the rules of techno chemical control of winemaking, the delivery time of grapes to the primary winemaking plant should not exceed 4 hours, and for the production of wines protected by appellations of origin - 2 hours [26].

The development of the Russian company ARDN Technology - the SKYF unmanned aerial cargo platform for vertical take-off and landing, is the first unmanned aerial vehicle of its kind for the transportation of agricultural products and has no analogs in the world. The use of the SKYF unmanned air cargo platform, equipped with specialized working bodies, will allow solving a wide range of tasks for the transportation and logistics processing of goods in the agricultural, and in particular, the wine industry (Fig. 1).

Fig. 1. The industrial model of unmanned air cargo platform SKYF

The conceptual innovative solution of the SKYF unmanned air cargo platform is a unique patented aerodynamic design based on the separation of the functions of the lifting and tail rotor. The internal combustion engine (ICE) directly drives the rotation of large fixed pitch propellers, resulting in the lifting force required for the platform to take off, while the auxiliary electric control screws provide the pitch and roll orientation of the platform (Fig. 2).

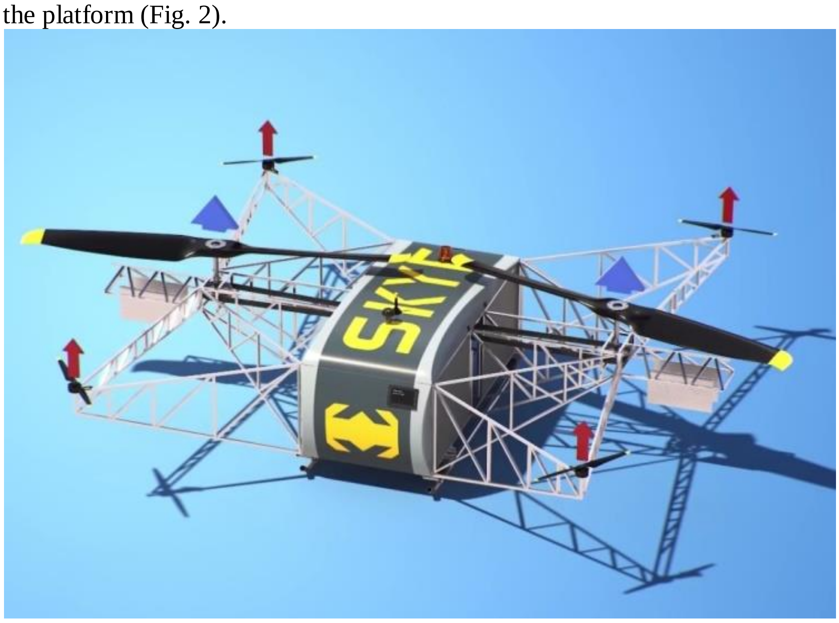

Fig. 2. The schematic diagram of the action of the lifting and tail screws

The use of such a control and launch scheme allows the use of DVG energy directly without additional electric sequential hybrid schemes, providing the SKYF unmanned air cargo platform with unique technical characteristics in terms of carrying capacity, fuel consumption, and flight range (Table 1).

Table 1. Technical characteristics of the unmanned air cargo platform SKYF

Technical characteristics	Parameters
Overall dimensions of the platform	5.2 x 2.2 meters
Maximum takeoff weight	up to 650 kg
Carrying capacity	up to 400 kg
Range of flight	up to 350 km
Flight duration	up to 8 hours
Gasoline consumption for 1 hour of operation	30 liters AI-95
Engine power	220 h.p.

Operations for the control of the unmanned air cargo platform SKYF are fully automated, the flight mission approved in the control center is protected with a cryptographic signature. Thus, the launch of the platform in potentially dangerous areas and directions is excluded. The SKYF unmanned air cargo platform has an autonomous parachute rescue system for the vehicle along with the cargo. Information control of the platform operation is carried out in real-time, by transferring information to the SKYF chain blockchain platform (Fig. 3).

Fig. 3. The center for information control of the SKYF work

The mass concentration of phenolic substances was determined by the colorimetric method. The qualitative and quantitative composition of phenolic compounds was determined by HPLC methods using an Agilent Technologies chromatographic system (model 1100) with a diode array detector (a Zorbax SBC18 chromatographic column was used to separate substances). The study of antioxidant activity was carried out on an amperometric flow-through analyzer "Tsvet Yauza-01-AA" with special software for collecting and processing data by the amperometric method, based on measuring the electric current arising during the oxidation of the test sample on the surface of the working electrode at a certain potential and comparing the obtained signal with a signal from a standard (quercetin) under the same measurement conditions.

The phenolic composition and the value of the antioxidant activity of samples of wine materials obtained from grapes of white technical European varieties of the species Vitis Vinifera, delivered for processing using an air cargo platform and without using it, are presented in Table 2.

Table 2. The phenolic composition and the value of the antioxidant activity of samples of wine materials, delivered for processing using an air cargo platform and without using it

		Name of wine material	
		Analysis without Skyf	Analysis with Skyf
Mass concentration, ma / dm3	Flavones	2,5	2,9
	Flavan-3-ols	89,6	98,6
	Hydroxybenzoic acids	24,8	25,8
	Hydroxycinnamic acids	106,2	129,9
	Caftaric acid	88,3	108,2

The phenolic component composition and AOA of wine samples obtained from grapes of white technical European varieties of the Vitis Vinifera species, delivered for processing using an air cargo platform and without using it, are presented in Table 3.

Table 3. The phenolic component composition and AOA of wine samples, delivered for processing using an air cargo platform and without using it

№	Name of wine material	Mass concentration, mg/dm^3		AOA, g/dm^3
		Oligomeric procyanidins	Polymeric procyanidins	
1	Analysis results without Skyf	167,3	1190,6	1,14
2	Analysis results using Skyf	175,2	1307,9	1,26

The use of the Skyf unmanned air cargo platform during the transportation of grapes makes it possible to obtain a wine material containing 1.15 times more monomeric forms of phenolic compounds and having a 1.11 times higher value of the antioxidant activity index than in wine material obtained using the traditional method of grape delivery and the subsequent process of its processing.

In the course of the research, it was found that the mass concentration of caftaric acid in the wine material prepared using transportation for processing by an unmanned air cargo platform Skyf is 18% higher than that in the wine material obtained from grapes, the delivery of which was carried out traditionally. Based on these data, it can be concluded that the use of the Skyf air cargo platform makes it possible to obtain wine materials with a lower degree of oxidation of phenolic compounds and, as a consequence, exhibiting greater antioxidant activity.

3 Conclusions

The time and conditions of transportation are of paramount importance for obtaining high-quality wines, this is primarily because grapes are characterized by a strong enzymatic-oxidative system. When using traditional methods of grape delivery in difficult mountainous conditions, the process of mechanical damage to grape bunches takes place, which leads to intensive oxidation of phenolic compounds, which are the source of antioxidant properties of wines, to quinones, caused by the oxidative enzyme phenoloxidase. The SKYF unmanned air cargo platforms described in this article can effectively solve both the problem of speed and the cost of delivery of grapes for processing.

References

1. Mukherjee, A., Misra, S., Raghuwanshi, N.S.: A Survey of Unmanned Aerial Sensing Solutions in Precision Agriculture, Journal of Network and Computer Applications vol 148, 10246 (2019), DOI: 10.1016/j.jnca.2019.102461
2. Moysiadis, V., Sarigiannidis, P., Vitsas V.: A Smart Farming in Europe, Computer Science Review, vol. 39, 100345 (2021), DOI: 10.1016/j.cosrev.2020.100345
3. Castillejo, P., Johansen, G., Cürüklü, B., Bilbao-Arechabala, S., Fresco, R., Martínez-Rodrígue,z B., Pomante, L., Rusu C., Martínez, Ortega, J.F., Centofanti, C., Hakojärvi, M., Santic, M., Häggman, J.: Aggregate Farming in the Cloud: The A far Cloud ECSEL project, Microprocessors and Microsystems vol. 78, 103218 (2020), DOI: 10.1016/j.micpro.2020.103218
4. Segade, S.R., Giacosa, S., Gerbi, V., Rolle, L.: Chapter 1 - Grape Maturity and Selection: Automatic Grape Selection, Red Wine Technology pp. 1-16 (2019), DOI: 10.1016/B978-0-12-814399-5.00001-3
5. Sinisterra-Solís, N.K., Sanjuán, N., Estruch, V., Clemente, G.: Assessing the environmental impact of Spanish vineyards in Utiel-Requena PDO: The influence of farm management and on-field emission modeling, Journal of Environmental Management, vol. 262, 110325 (2020), DOI: 10.1016/j.jenvman.2020.110325
6. Boursianis, A.D., Papadopoulou, M.S., Diamantoulakis, P., Liopa-Tsakalidi, A., Barouchas, P., Salahas, G., Karagiannidis, G., Wan, S., Goudos, S.K.: Internet of Things (IoT) and Agricultural Unmanned Aerial Vehicles (UAVs) in smart farming: A comprehensive review Internet of Things, 100187 (2020), DOI: 10.1016/j.iot.2020.100187

7. Librán-Embid, F., Klaus, F., Tscharntke, T., Grass, I.: Unmanned aerial vehicles for biodiversity-friendly agricultural landscapes - A systematic review, Science of The Total Environment, vol. 732, 139204 (2020), DOI: 10.1016/j.scitotenv.2020.139204
8. Kubyshkin, A.V., Avidzba, A.M., Borisyuk, V.S., Ageeva, N.M., Shramko, Y.I.: Polyphenols of red grapes in wine and concentrates for use in rehabilitation technologies, Sel'skokhozyaistvennaya Biologiya, vol. 52(3), pp. 622-630 (2017), DOI: 10.15389/agrobiology.2017.3.622rus
9. Solovyova, L.M., Grishin, Y.V., Kazak, A.N., Oleinikov, N.N., Chetyrbok, P.V.: The possibility of using the potentiometric titration method to determine the antioxidant properties of wines, Journal of Physics: Conference Series, vol. 1703 (1), 012048 (2020), DOI:10.1088/1742-6596/1703/1/012048
10. Zaitsev, G.P., Mosolkova, V.E., Grishin, Y.V., Chernousova, I.V., Ogai, Y.A., Avidzba, A.M.: Phenolic compounds in Cabernet-Sauvignon grape variety at wine-making farms of Crimea, Chemistry of plant raw materials, vol. 2, pp. 187-193 (2015), DOI: 10.14258/jcprm.201502548
11. Waterhouse, A.L., Sacks, G.L., Jeffery, D.W.: Understanding Wine Chemistry, Wiley Books, Adelaide (2016) ISBN 978-1-118-73072-0.
12. Dorofeeva, A.A., Kazak, A.N., Nyurenberger, L.B.: Wine tourism and the introduction of new technologies in winemaking and viticulture, IOP Conference Series: Earth and Environmental Science, vol. 315(7), 072040 (2019) DOI:10.1088/1755-1315/315/7/072040
13. .Kazak, A.N., Leushina, O.V.: 2019 Selected aspects of the use of technical innovation in the tourism industry, IOP Conference Series: Materials Science and Engineering, vol. 537(4), 042051 (2019), Doi: 10.1088/1757-899X/537/4/042051
14. Antonopoulos, K., Panagiotou, C., Antonopoulos, C. P., Voros, N.S.: A-FARM Precision Farming CPS Platform, 10th International Conference on Information, Intelligence, Systems and Applications (IISA), pp. 1-3 (2019), DOI: 10.1109/IISA.2019.8900717
15. Pino, M., Matos-Carvalho, J.P., Pedro, D., Campos, L.M., Costa, Seco J.: UAV Cloud Platform for Precision Farming, 12th International Symposium on Communication Systems, Networks and Digital Signal Processing (CSNDSP), pp. 1-6 (2020), doi: 10.1109/CSNDSP49049.2020.9249551.
16. Kovalev, I., Testoyedov, N.: Modern unmanned aerial technologies for the development of agribusiness and precision farming, IOP Conference Series: Earth and Environmental Science, vol. 548., 052080 (2020), Doi: 10.1088/1755-1315/548/5/052080
17. Hsu, M., Lee, T.: Autonomous Unmanned Air Vehicles (UAV) techniques, Proceedings of SPIE - The International Society for Optical Engineering, 6576 (2007), DOI: 10.1117/12.723182
18. Bhatia, K., Duda, D.: Precision Farming, International Journal of Trend in Scientific Research and Development. Vol.3, pp. 403-406 (2019), DOI: 10.31142/ijtsrd22793.
19. Shih, T., Hsieh, C., Lin, H., Chang, Yi., Shih, Jy.: (2019). A smart unmanned aerial system for precision farming management, Photonic Fiber and Crystal Devices: Advances in Materials and Innovations in Device Applications XIII, Vol. 11123 (2019), DOI: 10.1117/12.2532013
20. Yun, G., Mazur, M., Pederii, Yu.: Role of unmanned aerial vehicles in precision farming, Proceedings of the National Aviation University, Vol. 70(1) (2017), DOI: 10.18372/2306-1472.70.11430
21. Beluhova-Uzunova, R., Dunchev, D.: Precision farming – concepts and perspectives, Problems of Agricultural Economics, Vol. 360, pp. 142-155 (2019), 10.30858/zer/112132

22. Wiangtong, T., Sirisuk, P.: IoT-based Versatile Platform for Precision Farming, 18th International Symposium on Communications and Information Technologies (ISCIT), pp. 438-441 (2018), DOI: 10.1109/ISCIT.2018.8587989
23. Awais, M., Li, W., Muhammad, A., Faheem, M.: Using IoT Innovation and Efficiency in Agriculture Monitoring System, Journal of Botanical Research. Vol. 2 (2020), DOI: 10.30564/jrb.v2i2.1900
24. Jat, D., Limbo, A., Singh, C.: Internet of Things for Automation in Smart Agriculture: A Technical Review, 308 p. (2018), DOI: 10.4018/978-1-5225-5909-2.
25. Bascetta, L., Baur, M., Gruosso, G.: (2017). Electrical Unmanned Vehicle Architecture for Precision Farming Applications, IEEE Vehicle Power and Propulsion Conference (VPPC), pp. 1-5 (2017), DOI: 10.1109/VPPC.2017.8330907
26. Onte, S., Mandi, K., Bhattacharjee, S.: Precision farming - innovative agriculture, New Perspectives in Agricultural Sciences, 212p (2020).