Responsible investments in hop farming: foreign and domestic experience

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Abstract. The article examines the current trends in the investment activity of hop farming in the main hop-producing countries. The structure of investments in fixed assets of the industry in large specialized farms in the USA (Washington State University methodology), in small farms in the USA (joint methodology of the University of Michigan and Vermont), in average farms in Europe (SIMAHOP methodology of the Slovenian Institute of Hop Research and Brewing) and in farms of the Chuvash Republic — the main hop-producing region of Russia (model CCU of the Czech Republic "Agro-Innovations"). According to the results of the study, it was revealed that the hop growers bear the greatest investment costs at the initial stage — during the construction of the hop frames and the laying of hops. Capital investments at this point account for 50-60% of all long-term investments. On average, 15% to 19% of investments are invested in the purchase of specialized machinery and equipment. From 20% to 30% is occupied by investment costs for hop harvesting points.

1 Introduction

According to the theoretical approach, the term "responsible investments" mostly has ESG principles, i.e. assumes the prism of environmental, organizational and social orientation [1; 2]. In his work, the author mostly operated on the principles of responsible financial behavior of hop growers, i.e., a meaningful approach in relation to capital investments made in the industry. In this regard, it would be more accurate to use a term with a broader definition, namely, "socially responsible investments". Thus, the paper will focus on the level of sufficiency of financing for the hop industry in terms of determining the required amount of capital investments [3].

Hop farming is one of the most capital-intensive branches of agriculture, therefore, the issue of investment management in this industry remains one of the most important and urgent [4]. According to calculations by scientists of the Czech Agrarian University, the introduction of a hop-growing field on an area of 50 hectares and equipping the farm with the necessary machinery and equipment involves financing in the amount of 3.7 million euros (or more than 7 million rubles/ha at the rate of 1 euro = 97 Russian rubles) [5; 6]. Of these, a third of the amount is allocated for the construction of household units, another third for investments to prepare hops for sale and storage, and another third for general equipment and machinery [7]. According to the Association of hop growers of Russia at the beginning of

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2022, at the start of production it is necessary to invest at least 5 million rubles/ha in the formation of plantations on an area of 20 hectares. At the same time, the costs are distributed as follows: field preparation and a hop mixer — 40%, harvesting equipment and a hop dryer — 50%, all other equipment — 10% [8]. Since the structure of the industry's capital expenditures varies in the work of researchers, the purpose of the current work is to identify the exact structure of investments in hop farming, considering various aspects of the management of farmers in the main hop producing countries. This approach will make it possible to determine the main costs of business, which will serve as a good information base for increasing the investment attractiveness of the industry [9] and substantiating the strategic direction for improving the country's hop growing development policy [10].

2 Materials and Methods

To conduct a detailed analysis of the required capital investments in hop farming, an assessment of investment costs in the industry in the leading countries of hop production was carried out, namely: calculation of investments in the industry from Washington State University for ≈250 hectares of hop cultivation area [11], a joint model for calculating hop growers' budgets from the University of Michigan (Michigan State University) and the University of Vermont (The University of Vermont and State Agricultural College) for small plantations up to 8 hectares [12], a simulation model for analyzing the SIMAHOP hop industry developed by the Slovenian Institute of Hop Research and Brewing for 10 hectares [13], as well as the estimated budgeting model developed by the University of Pennsylvania for 90 hectares (the Pennsylvania State University) [14]. As a comparison, the Russian model of the feasibility study of hop production in the conditions of the Chuvash Republic of the State-owned unitary enterprise of the Chuvash Republic "Agro-Innovations" for 30 hectares of the hop-garden area is taken [15].

Each of these models has several sections of calculation data, if they are unified, then the following groups of indicators can be distinguished: a list of fixed assets (agricultural machinery, specialized equipment, machinery), production / operating expenses, management expenses, labor costs and the calculation model.

In this study, the author focused on identifying differences in the costs of fixed assets of hop growers in various methods, considering the introductory parameters unique to each case and the differences in the management of farmers from different countries, and also studied the structure of investment costs, identified the weaknesses and strengths of the adopted methods.

To begin with, let's present the structure of fixed assets embedded in each of the calculation models involved in monitoring.

The estimated cost of hop cultivation and production in the Pacific Northwest of the United States, developed by Washington State University, forms a calculation model for deeply specialized enterprises with an average area of hop cultivation of ≈250 hectares. The Northwest of the USA accounts for 75% of all hop areas, respectively, the list of fixed assets of the hop-growing enterprise is as complete as possible here.

A joint model for calculating hop growers' budgets from the University of Michigan and the University of Vermont was created for farmers with small hop plantations from 2 to 8 hectares [16].

The SIMAHOP simulation model for the analysis of the hop industry, developed by the Slovenian Institute for Hop Research and Brewing, was formed for use by hop growers of the European Union [17]. The farm growing hops on 10 hectares is taken as a basis. At the same time, the economic activity of the enterprise is much broader than the cultivation of hops [18]. Considering the fact that the development of scientists was formed according to

data for 2005, the total cost of fixed assets was recalculated considering inflation (+40%) and, for uniformity, converted into US dollars.

In Russia, the Chuvash Republic is the main hop-producing region of the country, which, according to data for 2022, accounts for 90% of the country's fruit-bearing hop areas [19]. The amount of necessary investments for the hop-producing enterprise of the subject on 30 hectares was presented by the State-owned Unitary Enterprise of the Chuvash Republic Agro-Innovations.

3 Results and Discussion

According to the source materials, a comparative table of the volume of capital investments of hop growers from different countries and their structure has been created (Tables 1 and 2). The main conclusions based on the results of the analysis of the capital investments presented in the calculation models are presented in Table 3.

Table 1. Summary of capital investments of hop growers, US dollars.

Indicator	**Washington State University Methodology, 2020**	**Methodology of the University of Michigan and the University of Vermont, 2016**	**Nethodology of the University of Pennsylvania, 2021**	**SIMAHOP Model (Slovenian Institute)**	**CCU of the Chuvash Republic "Agro-Innovations" (Russia, Chuvash Republic), 2023**
Estimated area, ha	267	4	90	10	30
Construction of a hop frames and laying of hops	4 939 500	164 308	x	237 197* / 243 378**	678 667
per 1 ha	**18,500**	**41 077**	**55 978**	**23 720 / 24 338**	**22 622**
Purchase of machinery, equipment and vehicles	9,966,000	46 000	x	77 784 / 128 194	191 111
per 1 ha	**37 326**	**11 500**	**1 142**	**7 778 / 12 819**	**6 370**
of these, machinery and vehicles	**3 446 (9%)**	**7 500 (65%)**	**-**	**3 678 (47%)**	**4 685 (74%)**
Cost of a hop harvesting point	8,125,000	51 000	x	81 513 / 163 025	431 111
per 1 ha	**30 431**	**12 750**	**-**	**8 151 / 16 303**	**14 370**
of these, drying equipment	**18 727 (62%)**	**1 875 (15%)**	**-**	**3 723 (46%)**	**6 667 (46%)**

packaging for sale	**11 236 (37%)**	**-**	**-**	**-**	**-**
Vehicles for specialists and service equipment	205,000	-	-	-	-
per 1 ha	**768**	**-**	**-**	**-**	**-**
Irrigation system	2,739,000	15 740	-	16 262 / 21 212	-
per 1 ha	**10 258**	**3 935**	**-**	**1 626 / 2 121**	**-**
Land cost	9,900,000	-	x	-	-
per 1 ha	**37 079**	**-**	**500**	**-**	**-**
Total investments per 1 ha	**134,362**	**69 262**	**57 620**	**41 275 / 55 581**	**43 362**

Calculated by the author using the methods of calculating investments of various schools mentioned in the text above.
* Calculations are presented using a correction factor.
** The amount of total capital investments for the purchase of fixed assets without using the correction factor.

Table 2. Structure of capital investments of hop growers, %.

Indicator	**Washington State University Methodology, 2020**	**Methodology of the University of Michigan and the University of Vermont, 2016**	**Nethodology of the University of Pennsylvania, 2021**	**SIMAHOP Model (Slovenian Institute)**	**CCU of the Chuvash Republic "Agro-Innovations" (Russia, Chuvash Republic), 2023**
Total investments per 1 ha	**100**	**100**	**100**	**100**	**100**
including					
for the construction of a hop frame and the laying of hops	**13.8**	**59,3**	**97,2**	**57,5**	**52,2**
for the purchase of machinery, equipment and vehicles	**27.8**	**16,6**	**2,0**	**18,8**	**14,7**
of these, machinery and vehicles	*2,6*	*10,8*	*-*	*8,9*	*10,8*
equipment	*25,2*	*5,8*	*-*	*9,9*	*3,9*
for the hop harvesting point	**22.6**	**18,4**	**x**	**19,8**	**33.1**

of these, drying equipment	*13,9*	*2,7*	*-*	*9.0*	*15,4*
packaging for sale	*8,4*	*-*	*-*	*-*	*-*
for vehicles for specialists and service equipment	**0.6**	**-**	**-**	**-**	**-**
for irrigation system	**7.6**	**5,7**	**x**	**3,9**	**-**
for land cost	**27.6**	**-**	**0.9**	**-**	**-**

Calculated by the author according to Table 1.

Table 3. Conclusions on the capital investments presented in the calculation models and their structure.

Model	Strong features	Weak features (according to the author)
Washington State University Methodology, 2020	The most thoughtful calculation model, as it was carried out for a deeply specialized hop-growing enterprise. The model has a complete list of all costs, both by line of business and by year.	1. There are many variations of specialized equipment in the list, which makes the model less versatile. At the same time, with respect to the selected large types of farms, such an approach may be acceptable. 2. The costs of purchasing equipment for the movement of workers and management personnel are included, which for individual farms may become an unnecessary expenditure of funds.
Methodology of the University of Michigan and the University of Vermont, 2016	1. The model makes it possible to calculate the effectiveness of the direction when preparing products for sale on their own or in the case of sending hops for revision to a third-party organization. 2. A fairly simple model, while allowing any farmer to calculate the main indicators of the industry.	1. The differences in management between small and larger farmers are not considered. 2. The availability of capital investments is calculated from the first year. The author finds it inappropriate to purchase a complete list of equipment in the first year, when harvesting of crops is not even provided.
The SIMAHOP model (Slovenian Hop and Brewing Research Institute), 2005	The use of correction factors is the strength of the model, since the machinery and equipment purchased by the hop farm can be used in various works, including those not related to hop farming — this practice is a significant innovation.	There is no division of the list of enginery, machinery and equipment by type of work. Perhaps it was necessary to divide the costs by the years of their implementation. Nevertheless, given that the rotation of hop transplants in Slovenia occurs every 15 years, the researchers probably considered it not essential to clarify the appearance of investment costs. According to the author, such an approach would make the model more accurate.
Methdology of the CCU of the Chuvash Republic "Agro-Innovations" (Russia,	A clear and accessible calculation model	The author believes that the model needs to be improved in terms of reviewing a number of investments. For example, specialized equipment is limited, it is necessary to provide for the availability of mechanization tools.

Chuvash Republic), 2023		
Nethodology of the University of Pennsylvania, 2021	The model is clear and accessible to use. All basic calculations have been carried out and all stages of hop growing are considered in the model.	1. Due to the use of a large number of calculation coefficients, the model, according to the author, is not universal for a wide range of users. At the same time, it may well be suitable for those territories for which it was developed. 2. The amounts of capital investments by types of fixed assets are not presented.

Compiled by the author based on the results of the analysis of tables 1-2.

4 Conclusion

The specifics of the *Washington State University* model is the purchase of all machinery and equipment in the property. In most other methods (except for the purchase of the CCU ChR "Agro-Innovations"), developers are considering the possibility of renting a part of the equipment, often specialized equipment. In the *Washington State University* model, land is also acquired by the company, which greatly increases the total investment amount by 27.6%. It is also the only model where, in addition to processing the product, expenses are included, including investment, for preparing hops for sale. For example, the cost of equipment for packaging hops is 8.4% of all investment costs. The specifics of the approach are also the prevailing share of specialized equipment in the total cost of costs, namely, 25.2%, and equipment accounts for 2.6% of costs. The share of equipment costs per unit area is leveled to minimum values here, in other calculation models, on the contrary, most of the costs in the section are occupied by equipment costs (in the European model, equipment and equipment costs are divided equally).

The methodology of the University of Michigan and the University of Vermont was calculated for small farms, respectively, this can explain a certain specificity of the approach. The calculation of a number of indicators was carried out on 2 or 4 hectares of the area of hop plantations. When increasing plantations, the cost calculation requires multiplying the initial level by the required amount of area. According to the author, this approach is not entirely correct, and does not consider the change in approaches to management. In terms of capital investments, the main field equipment is calculated in the property — these are standard machines and equipment used in crop production, namely: tractor, cultivator, mower, harrow, sprayer — for a total amount of 46 thousand US dollars or 4.14 million rubles (subject to 1 US dollar = 90 Russian rubles) on 4.05 hectares of hop area. Specialized equipment is rented.

About 60% of the hop grower's capital expenditures according to this method are accounted for by initial investments — this is the construction of a hop frames and the laying of hops. To carry out these works, the farmer often rents equipment and attracts hired labor resources. Due to the labor intensity and material intensity of growing crops [19], a small farm cannot start production on its own. At the same time, there is a noticeable difference in costs at the very initial stage of the work of large hop growers with 13.8% of costs and small farmers with 59.3% of costs.

It is also worth highlighting that in the USA the irrigation system is provided for all hop growers, including small farms. For which the cost of purchasing irrigation systems is 5.7% of all costs. The total capital investments in the model do not consider the cost of land.

The SIMAHOP model was designed in 2005. Unfortunately, the author did not have more up-to-date information, thus to compare the model's indicators with other calculations, the

investment amounts were increased by the cost of inflation by 2023 and multiplied by a factor of 1.4. Also, the cost indicators were calculated into US dollars.

The cost of fixed assets calculated in the SIMAHOP model using correction factors is a quarter lower than their full cost. The author believes that this approach more accurately reflects the cost of investment costs that fall specifically on the analyzed industry. Nevertheless, if there is a possible desire to use such an approach, researchers may face a number of problems, since it is quite difficult to derive such generally applicable coefficients. Since the indicators of the depth of specialization of farms vary not only in the context of countries or subjects of a particular country. But they can be completely different even within the same subject of the country. Perhaps the distribution of coefficients can be linked to the specific weight of hop plantations from the total land area of the organization. Nevertheless, the proposed approach requires additional study of the issue.

In the structure of investment costs, the researchers of the Slovenian Institute also do not include the cost of land, which significantly reduces the investment burden on the country's hop-growing enterprises.

In the *model of the University of Pennsylvania*, all specialized equipment (lifts, etc.) is rented, the costs of other equipment and machinery are calculated by the calculation method per unit area. According to the irrigation system, funds have been allocated for drip irrigation tape, nevertheless, no other costs have been allocated separately. The cost of land expenses is considered under the name "land fee" [20].

The model does not provide for the application of a separate list of capital investments, as was done in previous models. Accordingly, it is not possible to compare this model with the others.

In the *model of the CCU ChR "Agro-Innovations"*, a large share is the cost of equipment, namely, 74%, which is even more than that of farmers (the model of the universities of Michigan and Vermont is 65%), specialized equipment needed in hop farming is not considered. At the same time, in highly specialized farms (the Washington University model), their share is up to 90%. According to the author, the model needs to be improved by including a list of specialized equipment. Also, the cost of the hop harvesting point is one third of the hop grower's investment. This is at least 10% higher than in other models. It is necessary to consider the resulting costs in more detail in this section and identify the reason for the overstatement of expenditure items. The expenses of hop growers also do not consider the costs of the irrigation system, in other models these types of costs range from 3.9% to 7.6% of hop growers' investments.

The work carried out serves as a good information base for determining the required amount of investment costs of hop growing companies, considering their place of operation and the size of production activities.

The main provisions will be used by the author in further scientific research to determine the level of sufficiency of capital investments, as well as the general calculation of the efficiency of hop farms in Russia.

References

1. N. Lvova, Scientific journal NRU ITMOSeries "Economics and Environmental Management", **3,** 56-67 (2019). https://doi.org/10.17586/2310-1172-2019-12-3-56-67
2. E. Vostrikova, A. Meshkova, Financial Journal, **12(4),** 117-129 (2020). https://doi.org/10.31107/2075-1990-2020-4-117-129
3. N. Semenova, O. Eremina, M. Skvortsova, Finance: theory and practice, **24(2),** 39-49 (2020).

4. F. Mukhametgaliev, L. Mikhailova, A. Lukin, etc, Financial Business, **6(228),** 66-70 (2022).
5. K. Krofta, G. Fritschova, A. Mikyska, etc, Kvasny prumysl, **68(1),** 564-571 (2022). https://doi.org/10.18832/kp2022.68.564
6. K. Sredl, M. Prasilova, R. Svoboda, etc, Heliyon, **6(7),** e04371 (2020). https://doi.org/10.1016/j.heliyon.2020.e04371
7. O. Afanaseva, E. Ivanov, A. Makushev, Scientific Agrarian Journal, **10(23),** 114-123 (2023). https://doi.org/10.32417/1997-4868-2023-23-10-114-123
8. O. Afanaseva, E. Ivanov, L. Kornilova, Competitiveness in the Global World: Economics, Science, Technology, **3,** 180–185 (2023).
9. V. Matveev, I. Rezvyakova, Proceedings of the Southwest State University. Series: Economy. Sociology. Management, **10(4),** 114-124 (2020).
10. A. Petrikov, VEO of Russia, **235(3),** 122-133 (2022). https://doi.org/10.38197/2072-2060-2022-235-3-122-133
11. S. Galinato, Estimated costs of establishing and producing conventional and organic hops in the Pacific Northwest. [e-resource] (2022). URL: https://pubs.extension.wsu.edu/2020-estimated-cost-of-establishing-and-producing-hops-in-the-pacific-northwest (date of reference: 12.02.2024)
12. J. Porte, M. McKendree, Enterprise budgets are useful tools especially during uncertain times. [e-resource] (2021). URL: https://www.canr.msu.edu/news/enterprise-budgets-are-useful-tools-especially-during-uncertain-times (date of reference: 09.02.2024)
13. M. Pavlovic, Hop Bulletin, **13,** 21-31 (2006).
14. J. Harper, S. Cornelisse, L. Kime, J. Hyde, Hop production. Penn State Extension. [e-resource] (2021). URL: https://extension.psu.edu/hop-production (date of reference: 31.10.2023)
15. N.I. Vasilev (ed.), Tekhniko-ekonomicheskoe obosnovanie stroitel'stva shpaler, zakladki plantatsiy i proizvodstva khmelya v usloviyakh Chuvashskoy Respubliki [Feasibility study for the construction of trellises, planting plantations and hop production in the conditions of the Chuvash Republic], (Agro-Innovations, Cheboksary, 2023) 12.
16. J. Sirrine, N. Rothwell, E. Lizotte, etc, Sustainable Hop Production in the Great Lakes Region extension bulletin (USA: Michigan State University Extension, 2021).
17. M. Pavlovic, Benchmarking analysis of the EU Hop industry: Production, Organization, Marketing. [e-resource] (2012). URL: http://www.hmelj-giz.si/ihgc/doc/LDV%20R4%20-%20EU%20hop%20industry%20-%20partial%20report.pdf (date of reference: 09.02.2024)
18. F. Munisteri, D. Traon, H. Prins, M. Pavlovič, *Evaluation of the CAP measures related to hops: final report* (Brussels: Agriculture and Rural Development Directorate, 2010) 148.
19. O. Afanaseva, E. Ivanov, A. Makushev, etc, Economics of Agriculture of Russia, **8,** 129-135 (2023). https://doi.org/10.32651/238-129
20. J. Harper, S. Cornelisse, L. Kime, J. Hyde, Agricultural Alternatives: Budgeting for Agricultural DecisionMaking. Penn State Extension. [e-resource] (2019). URL: https://extension.psu.edu/budgeting-for-agricultural-decision-making (date of reference: 30.10.2023)