

**VALORIZATION OF WINERY WASTE. CASE OF THE REPUBLIC OF MOLDOVA****PhD student Cristina DIACONU***Technical University of Moldova, Chisinau, Republic of Moldova  
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larisa.bugaian@adm.utm.md***Abstract**

*The activity of enterprises in the wine sector is closely linked not only to the agro-cycle, but also to the biotechnological cycle, where by-products are also obtained in parallel with the basic products. The significant value of products that can be obtained from the processing of wine by-products, on the one hand, and the need to introduce them in new industrial circuits in order to align the economy of Moldova with the principles of sustainable development and circular economy on the other hand, were a motivation conducive to the selection of the research topic. Obviously, the circular economy is the excellent solution and opportunity to transform the current economy and make it more sustainable, as in a circular economy natural capital is used to its full potential, and waste is reintroduced into the circuit through sustainable reuse. In this sense, the whole system of resources must be approached throughout the value chain, including production methods, demand patterns, supply chains, waste management by designing “eco-friendly” alternatives for their recovery. In this context, this study is focused on highlighting the economic, environmental, social importance of capitalizing on wine by-products. The quantitative and value estimation of the potential products that can be obtained following the processing of secondary wine waste was performed based on the average annual grape harvest of the Republic of Moldova.*

**Key words:** *capitalization; circular; by-products; oil; tannin; tartaric acid*

**JEL Classification:** *Q01*

**I. INTRODUCTION**

Industry, which represents one of the most important sectors of the economy, and at the same time the main basis of the sustainable development of the country, has a special role in the development and economic growth of the Republic of Moldova.

What is certain is that both nationally and globally, more and more natural resources are being used, many of which do not have the capacity to regenerate, thus endangering the chances of future well-being of future generations.

For these reasons, it is essential to move to a circular economic development model, which by definition tends to “zero” waste.

The activity of enterprises in the wine sector is closely linked not only to the agro-cycle, but also to the biotechnological cycle, where in parallel with the basic products by-products are also obtained, which if not processed, capitalized, but stored in nature, cause major damage the environment.

Therefore, a sustainable industry in this sector requires innovative solutions in advantageous ecological and economic conditions. The whole resource system must be addressed throughout the value chain, including production methods, demand patterns, supply chains, waste management and the possibility of capitalizing on them.

Globally, the polluting load in the conditions of non-processing of wine by-products is estimated at the equivalent of a population of 3÷4 million inhabitants (Ciobanu, Leonte, Nedeff, & Lungulescu 2005).

In the Waste Management Strategy of the Republic of Moldova for the years 2013-2027, we find the information that in fact the food and beverage industry generates the largest amounts of waste in the Republic of Moldova.

The specialized literature estimates the amount of wine by-products at the level of about 25% of the size of the annual grape harvest.

According to the Wine Register of the Republic of Moldova, the average annual harvest of technical grapes of the last 3 years (2017-2019) equal to 280 thousand tons, would generate about 70 thousand tons

of by-products in the form of bunches, pomace, yeast, wine, etc., which could be capitalized in precious products such as oil, enotanin, arthric acid, protein flour, etc.

In the years 1982-1986, in the Republic of Moldova up to 10 thousand tons of seeds were obtained annually, which were transported and valorized in Tighina (oil factory), Odessa, Armavir (Krasnodar region), Tbilisi (Georgia), Kokand (Uzbekistan) (Duca, 2011).

Currently in the Republic of Moldova no seeds or oil are produced in industrial quantities for various reasons: lack of technology, uncertain benefits on the market, considerable investments, etc.

## II. STATISTICS ON WASTE MANAGEMENT IN THE WINE SECTOR OF REPUBLIC OF MOLDOVA

During the years 2010-2019 the global production of technical grapes processed by wineries varied within very wide limits.

The smallest quantity of 109 thousand tons was processed in 2010, and the largest quantity of grapes - 302 thousand tons - was processed in 2018, a variation of 2.77 times.

This is largely due to uncontrollable climatic factors such as: late spring frosts, hail in the early stages of vegetation and prolonged water stress in recent years.

Figure 1 presents the information on the amount of grapes processed in the period 2010-2019.

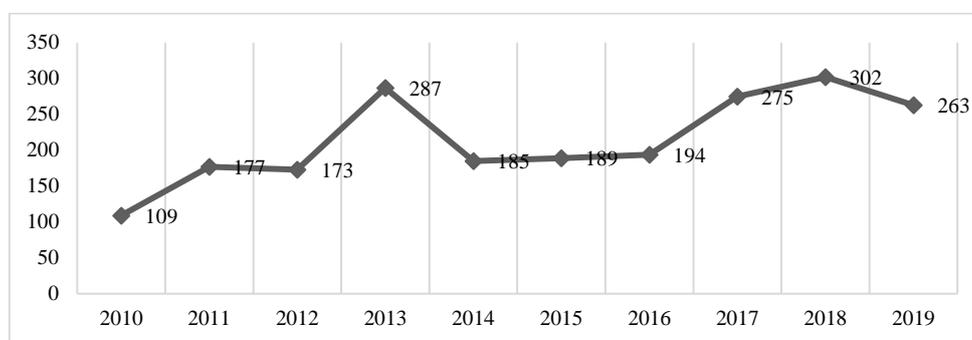


Figure 1 – Quantity of grapes processed in R.M. (2010-2019)

Source: elaborated by the author according to the data from the Wine Register of R.M.

Taking into account the high share ( $\approx 25\%$ ) of wine by-products resulting from the winemaking process and their uncontrolled disposal, it is necessary to find viable, feasible solutions in the medium and long term regarding their directions of capitalization. Today, however, enormous quantities of wine by-products are not reintroduced into new industrial circuits ending up as “waste”, negatively influencing the environment. According to the Production Declarations for 2019, submitted by the wine units of the Republic of Moldova, we deduct a significant amount of wine waste (point (22) of the declaration) equal to 58969.5 tons, of which 7572.2 tons of yeast sediment, 39253.2 tons of pomace and 12144.2 tons of bunches (Moldova's National Office of Vine and Wine, 2019).

Table 1 presents the information on the territorial distribution of wine waste of pomace, yeast, bunches.

Table 1. Territorial distribution of wine waste

The district	Yeast sediment waste - Quantity (hl)	Yeast sediment waste - Quantity (tons)	Waste – pomace (tons)	Waste - Bunches (tons)	Total (tons)	Share, %
Cahul	18999.0	1519.9	9170.9	2512.8	13203.6	22.4
UTA Găgăuzia	19631.7	1570.5	7396.2	2034.3	11001.0	18.7
Tiraspol	6853.7	548.3	4373.0	917.4	5838.7	9.9
Chişinău	4046.6	323.7	2476.6	726.7	3527.0	6.0
Străşeni	7411.0	592.9	2109.4	816.6	3518.9	6.0
Ialoveni	6391.6	511.3	1980.1	853.1	3344.5	5.7
Călăraşi	7639.3	611.1	2162.4	482.4	3255.9	5.5
Cantemir	6219.9	497.6	1933.8	711.7	3143.1	5.3

Ștefan Vodă	4300.9	344.1	1889.5	778.2	3011.8	5.1
Căușeni	2266.1	181.3	1279.4	411.8	1872.5	3.2
Leova	2441.2	195.3	930.4	410.2	1535.9	2.6
Fălești	1188.8	95.1	644.7	543.0	1282.8	2.2
Nisporeni	2219.1	177.5	526.2	182.1	885.8	1.5
Taraclia	1064.7	85.2	500.6	190.1	775.9	1.3
Anenii Noi	462.8	37	524.9	95.6	657.5	1.1
Orhei	1055.5	84.4	376.2	139.1	599.7	1.0
Basarabasca	566.2	45.3	357.5	109.6	512.4	0.9
Hîncești	1237.6	99.0	296.9	115.8	511.7	0.9
Cimișlia	590.8	47.3	307.0	107.9	462.2	0.8
Soroca	52.6	4.2	13.0	4.0	21.2	0.04
Ungheeni	13.1	1.1	4.6	1.8	7.5	0.01
Total	94652.3	7572.2	39253.2	12144.2	58969.58	100

Source: elaborated by the author according to Moldova's National Office of Vine and Wine, 2019

Therefore, we consider it essential from an economic, social and even vital point of view for the environment to design at national level an enterprise, cooperatives that would capitalize on the wine by-products from the enterprises in the country.

This measure would significantly contribute, on the one hand, to increasing the competitiveness and quality of wine products (by checking the chemical parameters of the collected pomace, thus avoiding excessive pressing of the pomace which generates inferior properties to wine), creating new business opportunities, new valuable products, new jobs, and on the other hand would reduce the negative impact on the environment.

### III. DIRECTIONS FOR CAPITALIZATION OF WINE BY-PRODUCTS

The significant value of products that can be obtained from the processing of wine by-products, on the one hand, and on the other hand the need to introduce them in new industrial circuits in order to align the economy of the Republic of Moldova with the principles of sustainable development and circular economy were conducive motivation in the selection of the research topic.

What is certain is that economic growth that is rapidly depleting the base of raw materials and energy, with wasteful consumption of “nature’s wealth”, can no longer be considered viable. The circular business model is the excellent solution and opportunity to transform the economy and make it more sustainable, whereas in a circular economy, secondary raw materials are commonly used to manufacture new products. Thus, in this subchapter we aim to highlight the wine by-products, their importance, alternatives of capitalization, and the identification of the most appropriate, viable, feasible variants to be implemented in the Republic of Moldova. In this context, we will start by briefly reporting the classic technologies of wine production, in order to highlight the resulting wine by-products in stages of manufacture.

So, the classic technologies used to obtain white and red wines for current consumption, can be divided into 2 major phases:

a. *Primary vinification comprising:*

- grape processing;
- fermentation of must;
- obtaining raw wine.

b. *Secondary vinification comprising:*

- wine processing;
- conditioning and bottling of wine.

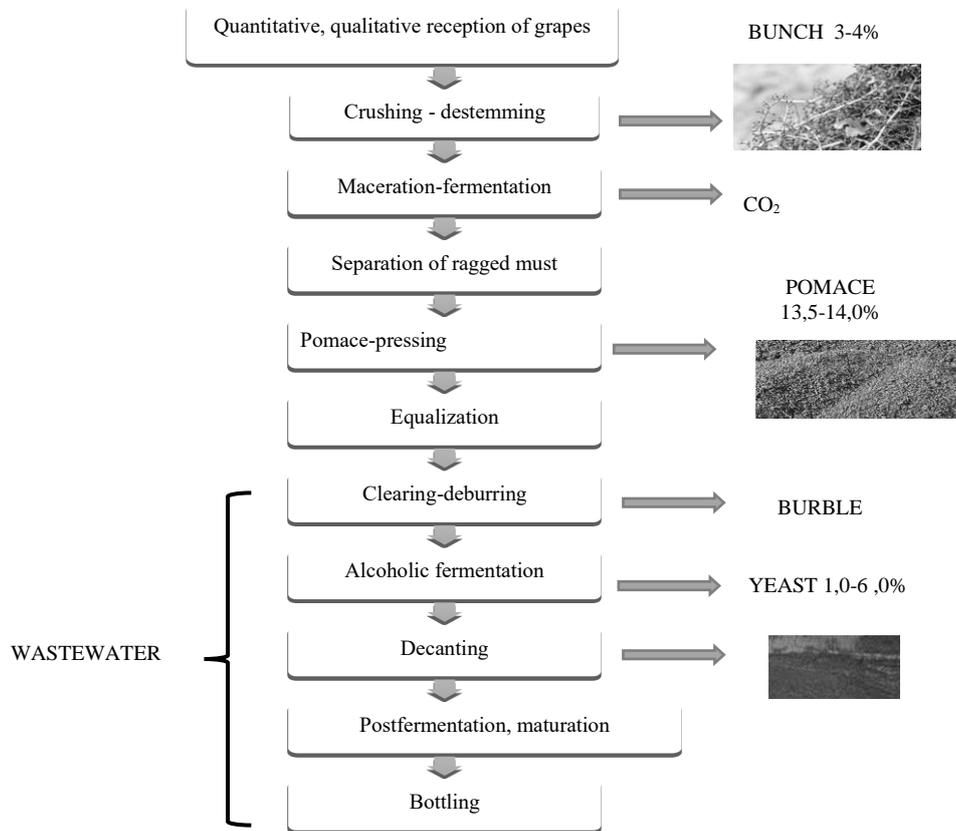
From harvesting the grapes to obtaining the wine, a series of technological operations take place during which significant quantities of wine waste are obtained that can be valorized (see fig 2).

The pomace, also called in the literature *boasca* or *boștină*, is the by-product resulting from the vinification process with the highest share - 13-14% of the total amount of grapes processed. The pomace is a mixture of husks, seeds and traces of grape pulp. Seeds represent 2-8% of the weight of the grape, respectively 40-65% of the mass of dried pomace (after pressing). (Țârdea, Sârbu & Țârdea, 2000).

From a chemical point of view, the pomace includes: water 57.5%, alcohol 3.34%, ash 2.55%, nitrogen 0.9%, substances soluble in alcohol 4.51%, cellulose 31.58%.

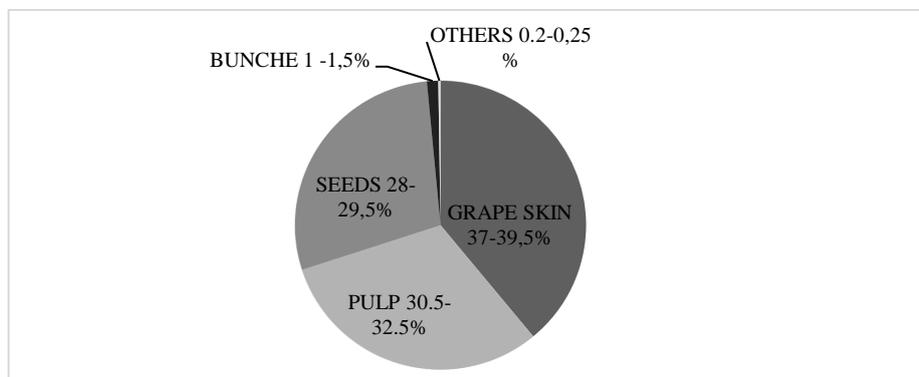
The most important by-products that can be capitalized are (see Figure 2):

- Pomace;
- Bunches;
- Yeast;
- Tartar (wine stone);
- Vinasse (comes from wine distillation).



**Figure 2 – Simplified wine production scheme**  
Source: elaborated by the author

From a physical-structural point of view, the composition of the pomace in relation to the dry substance is presented in Figure 3:



**Figure 3 – Physical-structural composition of pomace in relation to dry substance**  
Source: elaborated by authors according to Ciobanu et al. (2005: p. 252)

Chemically, pomace grape seeds, before drying, contain (Dorobanțu & Beceanu, 2007):

- water = 30-40%;

- protein = 6-10%;
- tannins = 3-7%;
- mineral substances = 1-2%;
- oils = 8-10%;
- cellulose = 44-57%.

The pomace, as a by-product of wine production, is rich in phenolic compounds, fatty acids that are very important for human health with antioxidant, anticancer, anti-inflammatory and antibacterial action (Özkan et al., 2004).

**Table 2. Pomace composition in fatty acids**

Fatty acids	Formula	Share, %
Palmitic	C <sub>16</sub> H <sub>32</sub> O <sub>2</sub>	6,6
Linoleic	C <sub>18</sub> H <sub>32</sub> O <sub>2</sub>	72,4
Oleic	C <sub>18</sub> H <sub>34</sub> O <sub>2</sub>	16,3
Stearic	C <sub>18</sub> H <sub>36</sub> O <sub>2</sub>	4,1
Linolenic	C <sub>18</sub> H <sub>30</sub> O <sub>2</sub>	<0.1
Palmitolinoleic	C <sub>16</sub> H <sub>30</sub> O <sub>2</sub>	<0.1

Source: elaborated by the authors according to Anđelković, et al. (2015)

The significant value of the products that can be obtained from the processing of pomace on the one hand, as well as the need for them to be introduced in the economic circuit, on the other hand, have conditioned the development of numerous extensive researches, studies and economically, socially, environmentally advantageous capitalization technologies.

In this order of ideas, the researches regarding the capitalization of the pomace converge towards 5 main identified directions:

- for the obtaining of ethyl alcohol;
- for the obtaining of grape seed oil;
- for the extraction of enotannin, the food colorant;
- for obtaining pomace compost;
- fodder.

Recent research has identified more and more food applications using pomace as a raw material for making pomace flour, which is subsequently incorporated in whole or in part into pastries and bakery products (Gaița, 2018).

*The bunches* form the skeleton of the grapes and represent 3-8% of their weight. The weight of the bunches depends on the variety, the degree of ripeness of the grapes, the sanitary condition of the harvest. The chemical composition of the bunches is close to that of the leaves and stalks: water 78-80%, cellulose 5-10%, tannin 3-5%, mineral substances 2-3%, nitrogenous substances 1.5-2%, etc (Țârdea et al., 2000).

The bunches also contain a significant amount of phenolic compounds (Ciobanu et al., 2005).

They can be further processed and transformed into natural fertilizer used in viticulture, as a component in animal feed materials, or as fuel.

*Wine yeast* is a wine by-product formed in containers following the fermentation of the must, storage of wine or must and the application of authorized treatments on musts and wines, as well as that separated by filtration or centrifugation of these products (Banu, 2009).

Under normal conditions, yeasts represent 5÷8% and can reach 12÷15% when using the continuous pressing process (Ciobanu et al., 2005).

Valuable products can be obtained from yeasts, as a secondary raw material, such as: alcohol, tartaric acid, feed flour from depleted yeasts.

Some literature sources also describe technological processes for obtaining yeast brandy, yeast wine, and enanthic ester from yeast.

*The tartar*, also called wine stone, tartar cream, is a wine by-product of salts of tartaric acid.

The tartar removal should be performed annually or at most every two years because the layer deposited on the inner walls of the containers is a source of infection with bacteria and mold.

The tartar can be used in calcium tartrate, tartaric acid.

*The vinasse* is a wine by-product of wine distillation. The processing of vinasses from distillations consists in the precipitation of tartrates with calcium chloride and lime milk. (Law no. 57, Republic of Moldova, 2006).

Next, the quantitative and value estimation of the potential products that can be obtained from the processing of wine by-products is presented, based on the average annual quantity of grapes processed by the wine enterprises from Republic of Moldova.

For a more accurate estimate of the quantity of wine by-products, as well as of the quantity of products that can be obtained after their capitalization, we extracted from various literature sources the size of the indicators of interest in this study, presented in Table 3:

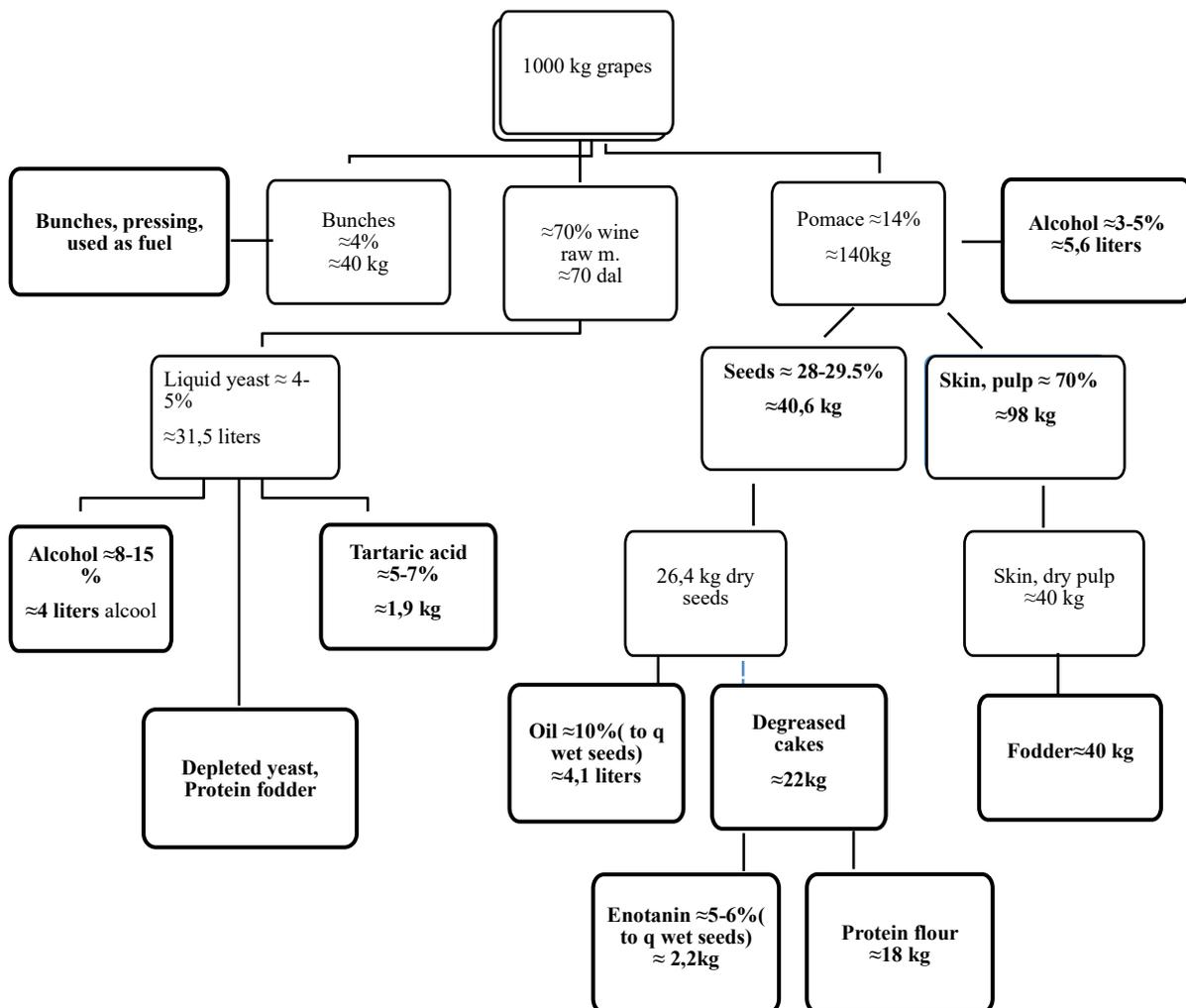
**Table 3. Composition / content characteristics of wine by-products**

Composition characteristics	(Duca, 2011)	(Ciobanu et al., 2005)	(Târdea et al., 2000)
The oil content in seeds (calculated on dry substance)	9.5÷20.0 %	13.0÷18.0 %	9.0÷18.0 %
The share of bunches in grapes	2.0÷3.0 %	2.5÷8.0 %	3.0÷8.0 %
Tannin content in seeds	6.0 %	3.0÷7.0 %	5.0 ÷8.0%

Source: elaborated by the authors

At the same time, the technological documentation with reference to the approached field was consulted.

Therefore, from one ton of grapes, through a rational capitalization of the resulting by-products, in addition to wine, can be obtained quantitatively: 9.6 liters of alcohol, 4 liters of oil, 1.9 kg of tartaric acid, 2.2 kg enotanin, 18 kg protein flour, 40 kg fodder with a current value of about 4800 lei.



**Figure 4 – Quantitative estimation of potential products that can be capitalized from by-products obtained from 1 ton of grapes**

Source: elaborated by the authors

Next, based on the wholesale prices selected from various commercial sites, we estimated the value of the total amount of products that can be obtained from the capitalization of wine by-products in the country. The results obtained are presented in Table 4.

**Table 4. Quantitative and value estimation of potential products that can be obtained from the capitalization of wine by-products based on the 2019 harvest of R.M.**

Products that can be obtained after capitalizing 1 ton of grapes		Estimated price, lei / unit	Estimated value, thousands of lei
Alcohol, (liters)	9,6	50,0	0,480
Oil, (liters)	4,0	90,0	0,360
Tartaric acid, (kg)	1,9	160,0	0,304
Enotinin, (kg)	2,2	1300,0	2,860
Protein flour (from seed) (kg)	18	35,0	0,630
Fodder, (kg)	40	4,0	0,160
<i>Estimated value of products obtainable from the recovery of by-products obtained from 1 tonne of grapes</i>			4,794
<i>Products that can be obtained after capitalizing the total quantity of pomace at national level (according to the harvest 2019-263000 tons, ≈36820 tons of pomace)</i>			
Alcohol, (thousand liters)	2524,8	50000,0	126240,0
Oil, (thousand liters)	1078,3	90000,0	97047,0
Tartaric acid, (tons)	499,7	190000,0	94943,0
Enotinin, (tons)	578,6	1300000,0	752180,0
Protein flour, (tons)	4734,0	35000,0	165690,0
Fodder, (tons)	10520,0	4000,0	42080,0
Estimated value of products that can be obtained from the capitalization on by-products from the total annual grape harvest 263000 tons			1278180,0

Source: elaborated by the authors

#### IV. RESULTS AND CONCLUSIONS

The need to design sustainable development and the circular economy that suggests maintaining harmony, balance between the social, economic and environmental aspects, has been determined by the concern about the wasteful consumption of natural resources that lead to climate problems and endanger the chance for the well-being of future generations.

Therefore, the main concern must be directed towards the valorization of by-products or other processes of restoration / reuse / recycling of waste or spent products.

The high share of the resulting wine by-products, the significant value of the derived products that can be obtained from their capitalization, as well as the need to align with the principles of a sustainable development of the sector, are sufficient arguments to adhere to the circular economic model.

The data presented in this study confirm the economic benefits that can be achieved, along with the conservation of natural capital through an efficient and almost “complete” use of the resources that nature offers us.

In this order of ideas, the estimated value of the products that can be obtained from the processing of wine by-products based on the 2019 annual grape harvest of R.M. constitutes 1278180.0 thousand lei.

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