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Economic efficiency of production of herbal granules

Summary. Improving production efficiency, increasing gross and marketable output is inextricably linked to comprehensive intensification, that is, with the growth of additional investments in the development of agricultural production. The increase in capital investments is the basis for strengthening and improving the material and technical base, and for implementing scientific and technological progress. Increasing the intensity of agriculture and animal husbandry contributes to more efficient use of land and livestock, increasing crop yields and livestock productivity. The main link between crop production and animal husbandry is feed production. Creating a solid feed base is the most important condition for the development of animal husbandry. Its state and level of development determine the possibility of increasing the number of animals, increasing their productivity, improving the quality of products and reducing the cost of the latter. It is proved that the level of productivity of animals by 50-80% is determined by their feeding. Due to the importance of feed, it is necessary that their production is ahead of the pace of needs (growth of livestock and its productivity). When forming a feed base, it is important to take into account not only the total volume of feed that will ensure the production of a certain amount of products, but also their balance with nutrients. As a rule, feed, namely green feed, silage, haylage, is not a commodity product, that is, there are no permanent markets for them. These types of feed are grown by those farms that are engaged in animal husbandry and must create their own raw material base for obtaining the main feed.

Key words: managerial decision making, feed production, the efficiency of the production of granulated feed

Introduction

Effective use of direct and indirect energy in the production of perennial grasses is now an extremely important area, and the definition of energy indicators for the production efficiency of these crops, in contrast to the monetary assessment to determine economic efficiency, allows to avoid the influence of factors such as the market value of products, raw materials, currency fluctuations, and the like.

The energy intensity of production from perennial grasses depends on many factors: weather conditions, soil type, agrotechnical measures, in particular, the method of sow-

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ing, the year of vegetation, the variety, and so on. However, as for the green mass, the latter does not represent a commodity product directly. Due to the significant weight, short storage time in unsuitable conditions, this type of feed is intended for feeding animals in the shortest possible time. Thus, a farm that does not even have livestock, while sowing perennial grasses, is able not only to take care of increasing soil fertility, but also sell them to the population for personal subsidiary farming, for example, by paying for the leased land share (subject to agreement between the parties)[1].

Taking into account market conditions, with modern technologies the production of haylage becomes promising. Thus, haylage packed in film directly in the field, even without the addition of preservatives, can be stored for a long time (up to one year) under normal conditions (for example, on a levelled site), and is suitable for transportation over any distance. This technology does not require additional material costs compared to the grass mass (except for the cost of film), but it allows you to avoid spoilage of feed due to non-compliance with the production technology, losses during transportation to the place of feeding to animals, which in turn helps to reduce both the production and total cost of livestock products and improve the efficiency of the industry. Thus, the silage in the film is the progressive commercial product[2].

Granulated feed has also gained its niche in the market of products of perennial grasses, the advantage of which is its almost 100% consumption. Granulated feed provides high gains in live weight of young animals on fattening, increases the milk productivity of cows, and plays an important role in the diet of animals that feed their offspring. The granules are especially useful for piglets and gestating pigs, rabbits, their colnum and lactating females. Among them, especially useful are alfalfa granules, which contain a balanced form of full-fledged protein, calcium, phosphorus and vitamins necessary for the growth and development of embryos of any agricultural animal.

[1] I. Horetska, S. Glowacki, T. Hutsol: Biomass Energy Potential After Beer Production. Actual aspects of development in the context of globalization, Abstracts of IX International Scientific and Practical Conference, International Science Group, Florence 2020, p. 100–101, http://188.190.33.55:7980/jspui/handle/123456789/7351 (access: 20.03.2020).; V. Kovalenko, N. Kovalenko, O. Labenko, O. Faichuk, O. Faichuk: Bioenergy sustainable development: achieving the balance between social and economic aspects, 6th International Conference – Renewable Energy Sources, E3S Web of Conferences 2020, vol. 154, https://www.e3s-conferences.org/articles/e3sconf/abs/2020/14/e3sconf_icores2020_07008/e3sconf_icores2020_07008.html (access: 20.03.2020).

[2] S. Francik, A. Knapczyk, A. Knapczyk, R. Francik: Decision Support System for the Production of Miscanthus and Willow Briquettes, Energies 2020, no 13(6), p. 1364. Doi: 10.3390/en13061364; N. Perederiy, V. Kovalenko: Economic Basis for the Creation of Fodder Base of the Enterprise, [in] International Scientific Days 2018. Towards Productive, Sustainable and Resilient Global Agriculture and Food Systems. Conference Proceedings, E. Horská, Z. Kapsdorferová, M. Hallová (Eds), Wolters Kluwer ČR, Nitra 2018, p. 840–851, http://www.slpk.sk/eldo/2018/dl/9788075981806/files/03/s3p10.html (access: 20.03.2020); В.П. Коваленко, Н.О. Коваленко: Планування кормової бази підприємства, Рослинництво та ґрунтознавство 2019, no 286, p. 35–42. http://journals.nubip.edu.ua/index.php/Agronomija/article/view/10833 (access: 20.03.2020).

Methods

For making management decisions, the following main methods of calculating the effectiveness of project implementation are most often used, based on the concept of discounting: method of determining net present value – Net Present Value (NPV); method of calculating the internal rate of return – Internal Rate of Return (IRR); method of calculating the payback period – Payback Period (PBP).

Net Present Value is the difference between the amount of cash receipts that are discounted to the present value and the amount of discounted present values of all costs required for the project implementation[3]. The calculation of the net present value can be expressed by the following formula:

$$NPV = \frac{H_{-m}}{(1+i)^{-m}} + ... + \frac{H_{-1}}{(1+i)^{-1}} + H_0 + \frac{H_1}{(1+i)^1} + ... + \frac{H_n}{(1+i)^n} +$$

$$+ \frac{B_{-m}}{(1+i)^{-m}} - ... - \frac{B_{-1}}{(1+i)^{-1}} - B_0 - \frac{B_1}{(1+i)^1} - ... - \frac{B_n}{(1+i)^n},$$

or

$$NPV = \sum_{t=-m}^{n} \frac{H_{tt}}{(1+i)^{tt}} - \sum_{t=-m}^{n} \frac{B}{(1+i)}$$

where:
H – is the amount of revenue for the period;
B – the amount of expenses for the period;
i – discount rate for bringing cash flows to their present value;
n, *m* – sequence numbers of the calculation period.

An important point is to choose the discount rate. In a broad sense, the discount rate is alternative investment opportunities with a similar level of risk. Or it is the rate of return that investors expect for their investments and which can encourage them to invest. The choice of approach to determining the discount rate depends on the specific situation and the information available to the analyst.

The Net Present Value (NPV) method is considered the main method for analyzing investment projects, but it has certain disadvantages. The first problem is related to forecasting such basic indicators as the marginal cost of capital, the amount of future investments and the amount of expected profit. The second problem is that the discount rate is constant for the entire operational period of the investment project. However, depending on economic changes in the country, the discount rate may increase or decrease. Another method for calculating investment efficiency is the Internal Rate of Return. Its essence is to determine the discount rate at which the current value of expected revenues will be equal to the current value of capital investments. The rate search is performed in an alternative way[4].

[3] В.П. Галушко, Г. Штрьобеля (Eds.): Виробнича економіка, Нова Книга, Вінниця 2005, p. 400.
[4] Ibidem, p. 400.

$$\text{Internal rate of return} = \text{The lowest calculation percentage} + \text{The difference between the smallest and largest percentages} * \frac{\text{Current cost at the lowest calculation percentage}}{\text{The absolute difference between current costs}}$$

In the calculations, the discount rate was taken as 14% per annum. From an economic point of view, the discount rate (or discount coefficient) is the return on investment that an investor usually receives from investments of a similar nature and risk. In fact, this is a possible rate of return. At the enterprise, determining the discount rate is complicated due to the variety of investment opportunities and the variety of financing through own and borrowed sources. The profit rate that is used to discount cash flows from capital investments must meet the minimum yield requirements, which provides the expected level of income.

Results and Discussion

It is well known (and it was mentioned earlier) that alfalfa has an important agrotechnical value. It enriches soils with nitrogen (60–120 kg/ha), improves their physical, biological properties and structure, and increases the content of organic matter. The roots of this crop penetrate deep into the soil (up to 3.0–3.5 m) and provide the plant with moisture even in dry years and on light soils that quickly dry up. In addition, growing alfalfa does not require any complex agrotechnological techniques, and a stable yield can be obtained within 2–3 years[5].

Granules from this plant are a feed protein-vitamin product made from alfalfa in the early stages of vegetation, dried at high temperature, grinded and pressed into granules. These feed granules contain 1.5–2 times more digestible protein, more minerals than grain feed, and they are significantly higher in carotene content than all other types of feed.

Abroad, alfalfa granules are very often used as an organic fertilizer in gardening and organic vegetable growing. They are popular because they contain growth stimulants and vitamins A and B1, which have a stimulating effect on plant roots. Alfalfa fertilizer is very common in the cultivation of roses[6].

[5] O. Ovcharuk, T. Hutsol, L. Mykhailova, N. Semenyshena, B. Dziedzic: Influence of sowing methods and seeding norms on crop production and Bean harvest, [in:] Scientific achievements in agricultural engineering, agronomy and veterinary medicine, F.M. Al Najjar, S. Głowacki, M. Wróbel (Eds), Traicon, Krakow 2017, p. 218–247, http://188.190.33.55:7980/jspui/bitstream/123456789/906/4/SAAEAVM-218-247.pdf (access: 20.03.2020).

[6] H. Demidas et al.: Indicators of organogenesis and productivity of alfalfa crops depending on the sowing period and cover culture, Feed and fodder production 2010, no 66, p. 183–188; O. Ovcharuk, T. Hutsol, O. Ovcharuk, V. Rudskyi, K. Mudryk, M. Jewiarz, M. Wróbel, J. Styks: Prospects of Use of Nutrient Remains of Corn Plants on Biofuels and Production Technology of Pellets, [in] Renewable Energy Sources. Engineering, Technology, Innovation, M. Wróbel, M. Jewiarz, A. Szlęk (Eds), Springer Proceedings in Energy, Springer, Cham 2020, p. 293–300. Doi: 10.1007/978-3-030-13888-2_29

The global market for alfalfa granules has been developing quite dynamically in recent years and is quite capacious (1.4 million tons). In terms of volume, it is not even inferior to the market of pressed hay. The increase in demand for vitamin and herbal granules is primarily due to the growing demand for food in the world in general and the active development of dairy farming and horse breeding in the countries of the Near and Far East.

The introduction of such feed into the diets of animals contributes to its balance in protein, amino acids, vitamins and trace elements, physiologically active substances, amides, as a result of which the animal body digests and assimilates all the feed more fully[7].

As found out, the use of alfalfa granules allows to achieve the following numbers in comparison with traditional feed: increased average daily milk yield of cows – by 7%; average daily gain of young cattle to 20; average daily gain of pigs – up to 15; average daily gain of poultry – 10; production of eggs – 12%.

In addition, all these indicators should be considered against the background of a 10% reduction in feed costs, primarily due to better preservation of nutrients, palatability and digestibility of alfalfa granules.

Now successful farms with large volumes of agricultural production and a closed production cycle to fully provide their own feed are returning to the use of irrigation on forage lands (Tab. 1).

Table 1. Calculation of economic efficiency of alfalfa granules production in Ukraine

Indicator	**Without irrigation**	**On irrigation [3000 m³/ha]**
The cost of green (grafted) mass	4,8 euro/t	8,0 euro/t
The cost of green (grafted) mass in terms of 12% dry matter in granules	17,0 euro/t	28,7 euro/t
Drying, granulation, labor costs, depreciation	6,4 euro/t	6,4 euro/t
Production cost of granules	23,6 euro/t	35,1 euro/t
Price for granules (15–19% crude protein)	85,0–104,2 euro/t	85,0–104,2 euro/t
Profit per 1 ton of granules	61,4–80,6 euro/t	49,9–69,1 euro/t
Granule yield from 1 ha of alfalfa	4,0 t	7,1 t
Profit from 1 ha of alfalfa	245,6–322,4 euro/ha	354,3–490,6 euro/t

Source: own elaboration.

[7] H. Demidas et al.: Indicators of organogenesis..., op. cit., pp. 183-188; S. Kuzmenko, N. Perederiy, O. Labenko: Market trends of oilseeds production in Ukraine. The Agri-Food Value Chain: Challenges for Natural Resources Management and Society, [in] International Scientific Days. The Agri-Food Value Chain: Challenges for Natural Resources Management and Society: Conference proceedings, E. Horská, Z. Kapsdorferová, M. Hallová (Eds), Slovak University of Agriculture, Nitra 2016, p. 54–61, http://www.slpk.sk/eldo/2016/dl/9788055215037/files/01/kuzmenko-et-al.html (access: 20.03.2020).

The EU experience is quite convincing about the need to increase the production of alfalfa granules. Thus, in the European Union, the cost of production of alfalfa granules is 90–130 euros/ton, including the cost of drying, selection and transportation of the dried mass. The economic efficiency of granule production depends directly on the nutrient content and the price level of wheat and soy.

Alfalfa granules with an energy content of 6.5 MJ NEL and 20% of crude protein at the price of feed wheat of 200 euros per ton and soy of 340 euros are approximately 200 euros per ton. If the price of soy and wheat is reduced by 10%, the price of granules will be 180 euros per ton, respectively. To a large extent, the cost of alfalfa granules can also be affected by the content of carotene. If you additionally buy beta-carotene, it will cost about 6–10 euro cents per 100 mg. It is known that the content of carotene in 1 kg of grass (alfalfa) silage or haylage is 100 mg lower than in granules, that is, granules can respectively cost another 60–100 euros more[8].

An important factor that can contribute to increasing the production of alfalfa granules in Ukraine, as well as increasing the chances of domestic products on foreign markets, may be the abolition of subsidies in the EU for the production of grass granules, grass flour or hay on artificial drying.

Given the importance and prospects of obtaining feed granules on the farm, it is planned to put into operation a granulator on the basis of the production division of the National University of bioresources and nature management of Ukraine, which will increase the profitability of feed production by obtaining commercial products – namely, feed granules. The specialists decided on the OGM-1.5 granulator, which costs 70,000 euros.

To load the capacity of the granulator, it is planned to allocate 100 hectares for sowing alfalfa for green feed, from which 3570 tons of green mass will be obtained per year, which in terms of feed granules will amount to 992 tons of granules per year.

However, since the cost of the granulator is high for the farm, there is a need to attract funding sources. Therefore, from here, a multi-period evaluation of the effectiveness of the investment project will help to answer the question: whether it is advisable to invest money in a project for the production of feed granules, provided that the equipment is operated for 10 years[9]. On the other hand, these calculations can help you find out how profitable the investment is, given the changes in the value of money over time. In order to give a full and exhaustive assessment of the investment project for the purchase of a granulator, it is necessary to take into account that the enterprise has the opportunity to receive a loan that is paid by the farm for 10 years, with an interest rate of 22%. The calculation of the multi-period variant of investment efficiency is given in Table 2.

[8] M. Wrobel et al.: Impact of raw material properties and agglomeration pressure on selected parmeters of granulates obtained from willow and black locust biomass. “Engineering for Rural Development” 2018, no. 17, pp. 1933-1938.

[9] Ринок люцернових гранул, 2013, https://www.poettinger.at/uk_ua/Newsroom/Artikel/5976/ (access: 20.02.2020).

Table 2. Multi-period calculation of the profitability of a granule production project

Specification	1	2	3	4–8	9	10
Yield of green mass of alfalfa from 100 ha [t]	0	3 570	3 570	...	3 570	3 570
Output of granules from 100 ha [t]		992	992	...	992	992
Cash flows excluding loans						
Revenue [euro]						
Realization of granules [euro]	0	84 292	85 978	...	98 761	100 736
Amount of revenue [euro]	0	84 292	85 978	...	98 761	100 736
Costs [euro]						
Purchase of equipment [euro]	–70 000					
Maintenanse [euro]		–700	–700	...	–700	–700
Costs of green mass [euro]		–28 461	–29 030		–33 346	–34 013
Costs of drying, granulation, wages, depreciation [euro]		–6 347	–6 474	...	–7 436	–7 585
The amount of costs [euro]	–70 000	–35 508	–36 204	...	–41 482	–42 298
Cash flow I	–70 000	48 784	49 774		57 279	58 438
Loan (22% per annum)						
Debtor's account	35 000	33 779	32 289	...	7 313	0
Annuity		8 921	8 921	...	8 921	8 921
Getting a loan	35 000					
Interest on the loan		7 700	7 431	...	2 927	1 609
Payment of the loan		1 221	1 490	...	5 994	7 313
Payment for services for obtaining a loan	–200					
Cash flow on the loan	34 800	–8 921	–8 921	...	–8 921	–8 921
Cash flow II	–35 200	39 863	40 853	...	48 357	49 517
Discount factor 14%	100 000	0,87719	0,76947	...	0,30751	0,26974
disc. Cash flow II	–35 200	34 967	31 435	...	14 870	13 357
NPV	191 389					
IKV	116%					

Source: own elaboration.

So, according to the calculations, the proposed version of the project calculation is profitable. This is evidenced by the net present value (NPV) indicators, which show the difference between the present value of profit and investment costs. If you get a loan for 50% of the cost of equipment, the net present value is positive and amounts to 191,389 euros, which means that the project has the right to exist and to put into practice.

For the presented project, the internal rate of return (IRR), calculated using Excel, was 116%, which is more than an alternative (14%), and indicates a positive assessment

of the proposed investment. In other words, the entire invested capital is returned in full with sufficient income.

If you calculate the internal rate of return for an investment without borrowing, it is 71%, which is also a cost-effective indicator.

Therefore, the production of alfalfa granules can not only be an alternative to growing highly profitable crops, besides having a positive impact on soil fertility, but also become an independent, highly profitable business line, allowing farms to differentiate their activities and minimize risks. There are all the prerequisites for this: our own competitive advantages (fertile soil, cheaper resources), high demand in the foreign market, and a potentially quite capacious domestic market.

Conclusion

The formation of a high-quality feed base is one of the most important elements of profitable development of the livestock industry in Ukraine. The use of perennial legumes is of great agricultural importance for the state. They contribute to the accumulation of humus in the soil, which is a source of nutrients for plants and contributes to the development of useful soil microorganisms. Legumes enrich the soil with nitrogen and are good precursors in crop rotation for many crops.

The analysis of the use of feed granulator in the Separated Subdivision of National University of Life and Environmental Sciences of Ukraine showed the economic effect of investing in this innovative project. The net present value (NPV) of using the granulator, as shown by calculations, is 191,389 euros due to financing by loan-like means, and the internal rate of return (IRR) is 116%.

In order to make products competitive and quickly bring it to the consumer (buyer), farmers in their activities very successfully use a number of marketing activities. Manufacturers of green feed are trying to attract the attention of customers to their products and not only because of the variety of its range and quality. Information resources, i.e. advertising, work with high efficiency. With the spread of the Internet, producers in remote areas of the region can declare themselves by creating their own website.

Products of perennial grasses, including seeds, are produced quite effectively in Europe and are highly adaptable to various conditions (frost-drought resistance, resistance to dust and gas, as well as high resistance to diseases and pests).

References

Демидась Г., Івановська Р., Коваленко В., Малинка Л.: Показники органогенезу і продуктивність люцерни посівної залежно від строку сівби та покривної культури, Корми і кормовиробництво 2010, no 66, p. 183–188.

Francik S., Knapczyk A., Knapczyk A., Francik R.: Decision Support System for the Production of Miscanthus and Willow Briquettes, Energies 2020, no 13(6), p. 1364. Doi: 10.3390/en13061364

Horetska I., Glowacki S., Hutsol T.: Biomass Energy Potential After Beer Production. Actual aspects of development in the context of globalization, Abstracts of IX International Scientific and Practical Conference, International Science Group, Florence 2020, p. 100–101, http://188.190.33.55:7980/jspui/handle/123456789/7351 (access: 20.03.2020).

Kokovikhin S., Kovalenko V., Slepchenko A., Tonkha O., Kovalenko N., Butenko A., Ushkarenko V.: Regularities of sowing alfalfa productivity formation while using different types of nitrogen fertilizers in cultivation technology, Modern Phytomorphology 2020, no 14, p. 35–39, https://www.phytomorphology.com/articles/regularities-of-sowing-alfalfa-productivity-formation-while-using-different-types-of-nitrogen-fertilizers-in-cultivation.pdf (access: 20.03.2020).

Kovalenko V., Kovalenko N., Labenko O., Faichuk O., Faichuk O.: Bioenergy sustainable development: achieving the balance between social and economic aspects, 6th International Conference – Renewable Energy Sources, E3S Web of Conferences 2020, vol. 154, https://www.e3s-conferences.org/articles/e3sconf/abs/2020/14/e3sconf_icores2020_07008/e3sconf_icores2020_07008.html (access: 20.03.2020).

Kuzmenko S., Perederiy N., Labenko O.: Market trends of oilseeds production in Ukraine. The Agri-Food Value Chain: Challenges for Natural Resources Management and Society., [in] International Scientific Days. The Agri-Food Value Chain: Challenges for Natural Resources Management and Society: Conference proceedings, E. Horská, Z. Kapsdorferová, M. Hallová (Eds), Slovak University of Agriculture, Nitra 2016, p. 54–61, http://www.slpk.sk/eldo/2016/dl/9788055215037/files/01/kuzmenko-et-al.html (access: 20.03.2020).

Ovcharuk O., Hutsol T., Mykhailova L., Semenyshena N., Dziedzic B.: Influence of sowing methods and seeding norms on crop production and Bean harvest, [in:] Scientific achievements in agricultural engineering, agronomy and veterinary medicine, F.M. Al Najjar, S. Głowacki, M. Wróbel (Eds), Traicon, Krakow 2017, http://188.190.33.55:7980/jspui/bitstream/123456789/906/4/SAAEAVM-218-247.pdf (access: 20.03.2020).

Ovcharuk O., Hutsol T., Ovcharuk O., Rudskyi V., Mudryk K., Jewiarz M., Wróbel M., Styks J.: Prospects of Use of Nutrient Remains of Corn Plants on Biofuels and Production Technology of Pellets, [in] Renewable Energy Sources. Engineering, Technology, Innovation, M. Wróbel, M. Jewiarz, A. Szlęk (Eds), Springer Proceedings in Energy, Springer, Cham 2020, p. 293–300. Doi: 10.1007/978-3-030-13888-2_29

Perederiy N., Kovalenko V.: Economic Basis for the Creation of Fodder Base of the Enterprise, [in] International Scientific Days 2018. Towards Productive, Sustainable and Resilient Global Agriculture and Food Systems. Conference Proceedings, E. Horská, Z. Kapsdorferová, M. Hallová (Eds), Wolters Kluwer ČR, Nitra 2018, p. 840–851, http://www.slpk.sk/eldo/2018/dl/9788075981806/files/03/s3p10.html (access: 20.03.2020).

Wróbel M., Mudryk K., Jewiarz M., Knapczyk, A.: Impact of raw material properties and agglomeration pressure on selected parmeters of granulates obtained from willow and black locust biomass, Engineering for Rural Development 2018, no 17, p. 1933–1938. Doi: 10.22616/ERDev2018.17.N542

Галушко В.П., Штрьобеля Г.: Виробнича економіка, Нова Книга, Вінниця 2005.

Коваленко В.П., Коваленко Н.О.: Планування кормової бази підприємства, Рослинництво та ґрунтознавство 2019, no 286, p. 35–42. http://journals.nubip.edu.ua/index.php/Agronomija/article/view/10833 (access: 20.03.2020).

Ринок люцернових гранул, 2013, https://www.poettinger.at/uk_ua/Newsroom/Artikel/5976/ (access: 20.02.2020).